STEELHEAD SUPPLEMENTATION STUDIES IN IDAHO RIVERS

TO EVALUATE THE FEASIBILITY OF USING ARTIFICIAL PRODUCTION TO INCREASE NATURAL STEELHEAD POPULATIONS AND TO COLLECT BASELINE LIFE HISTORY, GENETIC, AND DISEASE DATA FROM NATURAL STEELHEAD POPULATIONS

1993 ANNUAL REPORT

For activities completed January 1, 1993 through December 3 1, 1993

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IDFG 96-01
Project Number 90-055
Contract Number DE-BI79-89BPO1466

January 1996

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ABSTRACT

The Steelhead Supplementation Study was designed to evaluate the feasibility of using artificial production to increase natural steelhead *Oncorhynchus mykiss* populations and to collect baseline life history, genetic, and disease data from natural steelhead populations. To evaluate supplementation, we focused our experimental design on post-release survival, reproductive success, long-term fitness, and ecological interactions. We began field experiments in 1993 by outplanting hatchery adults and fingerlings to assess reproductive fitness and long-term survival. We snorkeled eight streams to estimate juvenile steelhead densities, recorded temperatures in 17 streams, and tagged natural steelhead in six streams with Passive Integrated Transponder (PIT) tags.

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INTRODUCTION

The goal of supplementation is to increase natural fish production using artificial propagation without a negative effect on the productivity and abundance of existing natural populations. Supplementation has been identified as a potential tool to increase anadromous fish runs in the Columbia River Basin (Regional Assessment of Supplementation Projects; (RASP) 1992, Northwest Power Planning Council (NPPC) 1987). Although a sustainable benefit from supplementation is unlikely without an improvement in passage conditions through the federal hydrosystem in the Snake and Columbia rivers, supplementation may help rebuild Idaho steelhead *Oncorhynchus mykiss* populations.

The goal of supplementation: an increase in natural production, without negative impacts on the natural target and non-target populations, is a departure from previous hatchery management. The major supplementation question that needs to be resolved is whether it is possible to integrate artificial and natural production without an unacceptable risk to natural populations. Potential supplementation risks include: reducing natural productivity below sustainable levels through genetic introgression with a less fit supplementation stock, displacement of naturally produced fish through behavioral interactions with supplementation fish, transmission of diseases, excessive straying of returning hatchery adults, and inadvertent selection or domestication of donor stocks brought into the hatchery. These risks should be addressed before the implementation of large scale supplementation programs.

In this study, we incorporated the RASP planning guidelines (RASP 1992) of describing the present and desired future condition of the stream and stock to design strategies to reach the desired future condition. Our research investigates four performance standards identified by RASP to evaluate supplementation: post-release survival, reproductive success, long-term fitness, and ecological interactions. We are investigating the potential benefits and risks of supplementation with small-scale experiments. Knowledge from this research will be used to guide steelhead supplementation decisions in Idaho.

The experimental design for the Steelhead Supplementation Study (SSS) was submitted to the Bonneville Power Administration (BPA) in December 1992 (Byrne 1994). Field work began in March 1993. We focused our 1993 field experiments in Beaver and Frenchman creeks, Salmon River tributaries upstream of Stanley, and the South Fork Red River in the South Fork Clearwater River drainage. The focus of our 1993 work was implementing experiments to evaluate reproductive success, long-term fitness, and to collect baseline data from wild steelhead stocks within Idaho.

OBJECTIVES

The objectives and major questions of this project are:

1. Assess the performance of hatchery and wild brood sources to reestablish steelhead in streams where extirpated.

Questions: Which brood source has the highest survival rate from:

a) egg-to-smolt in the hatchery environment,
b) smolt-to-adult (post-release) in the natural environment,
c) egg-to-age 1 in the natural environment, and
d) egg-to-smolt in the natural environment?

2. Evaluate the ability of returning adults from hatchery smolt and fingerling releases to produce progeny in natural streams.

Question: Which group of adults, that return to spawn naturally, from a smolt or fingerling stocking produce the most progeny?

3. Estimate recovery rates and the frequency of supplementation required to establish viable steelhead populations in restoration rivers.

Question: How many fish and how long is supplementation required to reestablish steelhead in streams where extirpated?

4. Evaluate broodstock management at existing weirs in relation to natural production objectives.

Question: What broodstock management policy best meets steelhead natural production goals upstream of hatchery weirs?

5. Assess the abundance, habitat, and life history characteristics of existing steelhead populations in the Salmon and Clearwater river drainages.

Questions: For our natural and wild steelhead populations:

a) What were the historical stream and stock characteristics?
b) What is the status, trend, and performance attributes of steelhead stocks within Idaho?
c) Are habitat and survival adequate for supplementation to be successful?
d) How do we best match donor to recipient stocks and habitat requirements for supplementation?
e) Can kelts or residualized steelhead be used as a donor source for supplementation purposes?

6. Assess the behavioral and ecological effects of supplementation on natural chinook salmon 0. *tshawytscha,* steelhead, and resident trout populations.

Question: What are the ecological and behavioral effects of supplementation?

7. Evaluate post-release survival of fish raised by alternative hatchery techniques in comparison to conventional hatchery practices.

-Question: Can alternative rearing strategies increase post-release survival of hatchery fish?

Full implementation of the experiments was not planned until 1995. In 1993, work began on Objectives 1, 2, and 5. We gathered baseline data, assessed streams for their feasibility for use in future experiments, and began field experiments for Objectives 1 and 2. The Lower Snake River Compensation Plan Hatchery Evaluation Project has the primary responsibility for Objective 7. The Steelhead Supplementation Study (SSS) provides technical assistance designing the Objective 7 experiments.

STUDY AREA

Steelhead supplementation research is conducted in the Clearwater and Salmon river drainages of Idaho (Figures 1 and 2). This research effort is closely coordinated with other Idaho Department of Fish and Game (IDFG) projects including: Idaho Supplementation Studies (ISS; BPA project 89-0981, Intensive Smolt Monitoring (ISM; BPA project 91-0731, and General Parr Monitoring (GPM; BPA project 91-073). In 1993, steelhead supplementation crews snorkeled six streams in the Salmon River drainage and two streams in the Clearwater River drainage (Table 1). Stream temperatures were recorded in 17 streams. Idaho Supplementation Studies personnel collected and passive integrated transponder (PIT)-tagged juvenile steelhead at screw traps on Red River, Marsh Creek, Crooked Fork Creek, and South Fork Salmon River. We began field experiments, for Objectives 1 and 2, in Beaver Creek, Frenchman Creek, and the South Fork Red River.

METHODS

Adult Steelhead Collection and Outplants

Collection of Adults

The experimental design called for us to stock two streams with hatchery adults and two streams with wild adults. Because we lacked baseline data, and this was the first year of the study, we decided to stock only one stream with hatchery adults and one with wild adults. Hatchery adults were obtained from returns to the Sawtooth Fish Hatchery. We planned to collect wild fish from the Salmon River downstream of Corn Creek. IDFG personnel and local fishing guides worked cooperatively to collect wild adult steelhead caught by anglers and transport them to Sawtooth Fish Hatchery. However, due to unfavorable water conditions and low numbers of wild fish, we were unable to collect enough wild adults for the experiment.

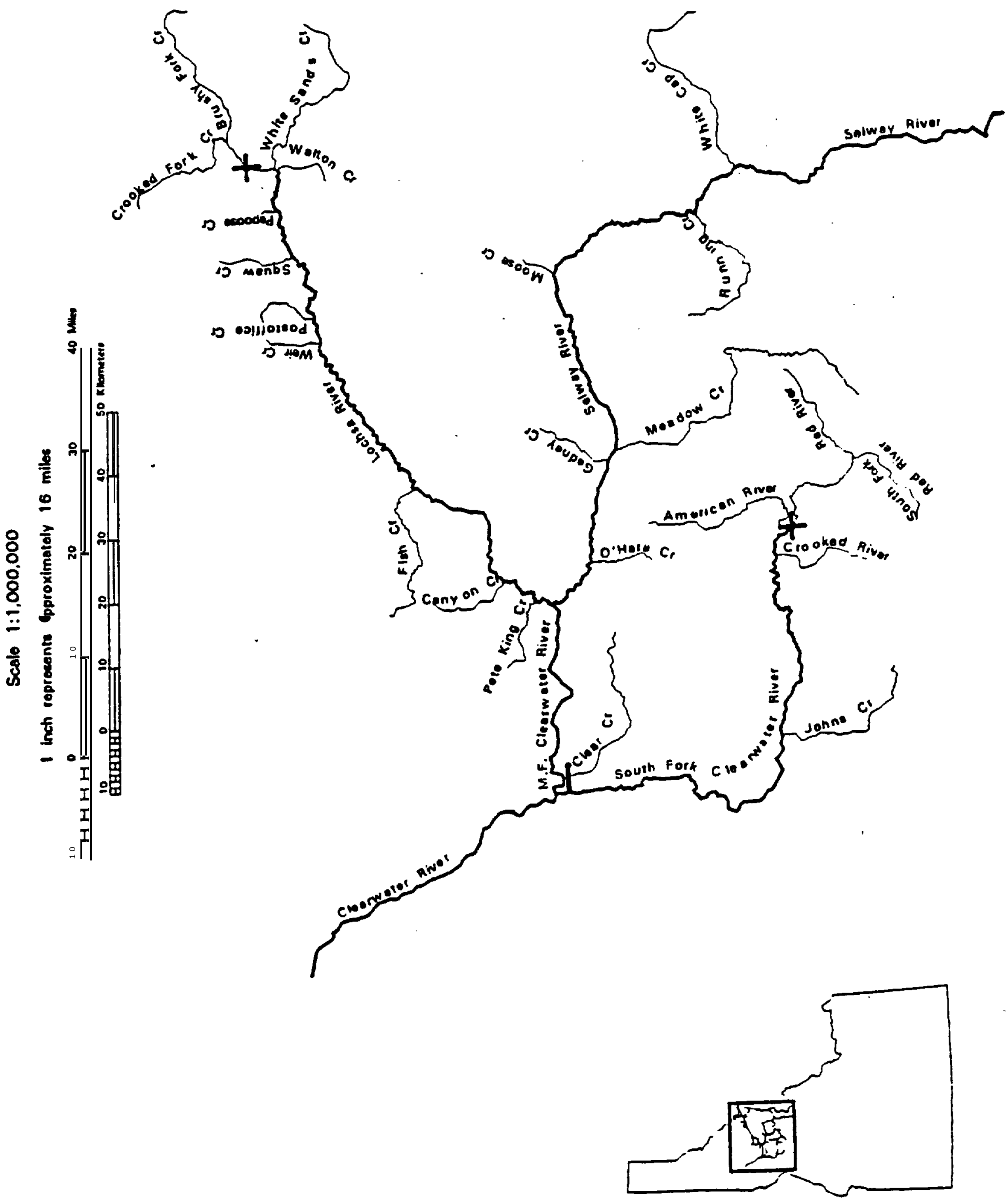


Figure 1. Location o the study streams in the Clearwater River drainage.

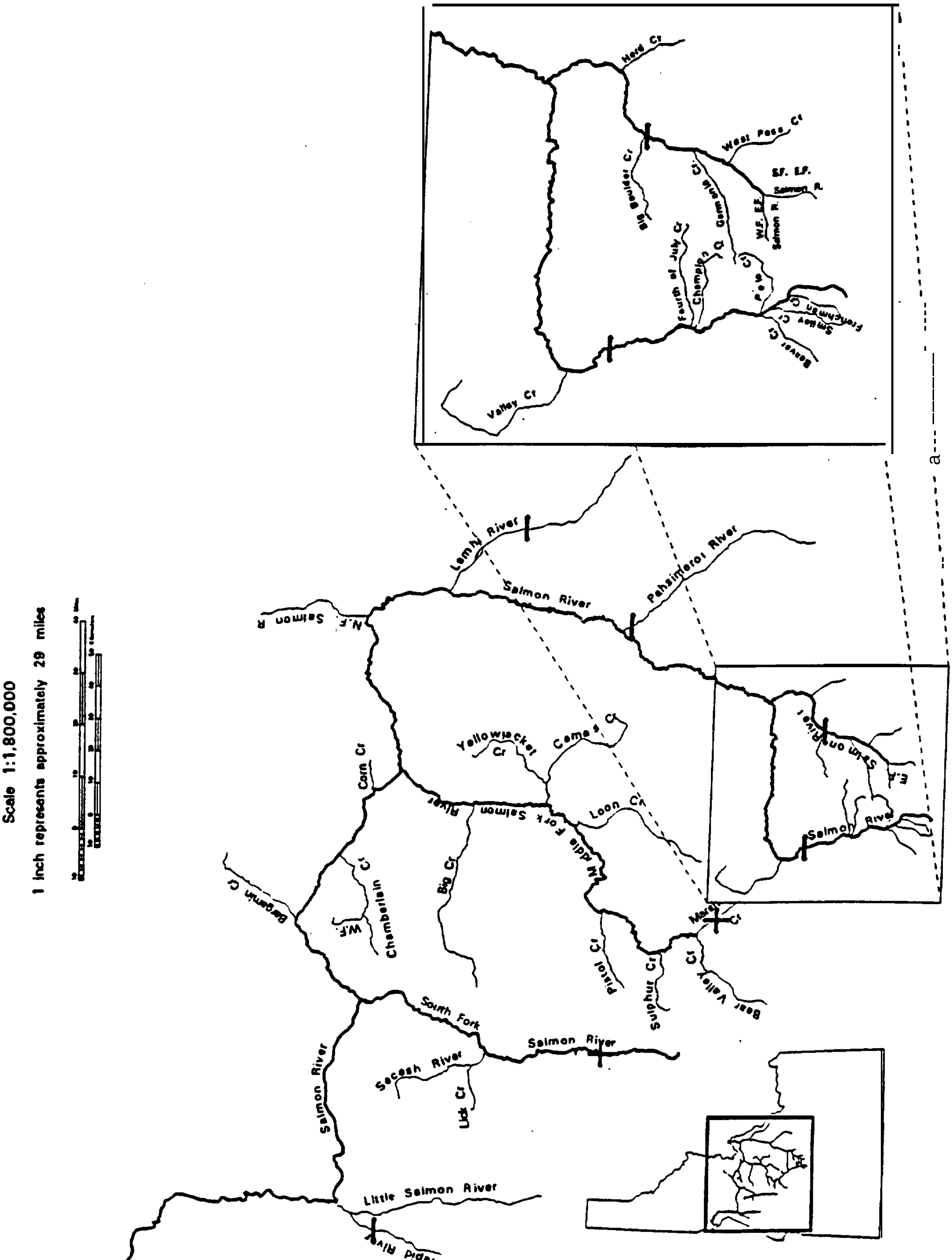


Figure 2. Location of the study streams in the Salmon River drainage.

Table 1. The types of data collected from study streams in 1993 for steelhead supplementation studies. A dash indicates that no data was collected.

Stream	Stream snorkeled	Habitat survey	Stream temperature	Juveniles PIT-tagged
Clearwater River Drainage				
Canyon Creek		-	Y	
Crooked Fork Creek	Y[a]	Y	Y	Y[c]
Fish Creek	Y	-	Y	Y
Post Office Creek		-	Y	
Red River	Y[a]	Y	Y	Y[c]
South Fork Red River	Y	Y	Y	Y
Walton Creek		-	Y	
Weir Creek	_	-	Y	
Salmon River Drainage				
Beaver Creek	Y	Y	Y	
Chamberlain Creek	Y[b]	-	Y	
Frenchman Creek	Y	Y	Y	
Germania Creek	Y	-	Y	
Marsh Creek	Y[a]	Y	Y	Y[c]
South Fork East Fork Salmon River	Y	-		
South Fork Salmon River	Y[a]	Y		Y[c]
Valley Creek	Y[a]	Y	Y	
West Fork East Fork Salmon River	Y	-		
Rapid River	Y[b]			Y[c]
Smiley Creek	Y[b]	-	Y	
East Fork Salmon River at Bowery	Y[a]		Y	
West Pass Creek	Y	Y	Y	

a Snorkeled by ISS crews.
b Snorkeled by other IDFG crews.
c Fish tagged at traps operated by other IDFG personnel.

Outplanting Adults

We stocked hatchery adults that had returned to Sawtooth Fish Hatchery, in Beaver and Frenchman creeks, to evaluate the reproductive success and long-term fitness of the stock for supplementation. We placed temporary picket weirs at the upstream and downstream boundaries of a 1 km (approximately) stream section before stocking the adults into Frenchman Creek (Figure 3). In Beaver Creek, we placed a picket weir at the downstream boundary and used a 1.5 meter high beaver dam for the upstream boundary (Figure 4). There was 1.0-l .5 m of snow on the ground at stocking time that prevented vehicle access to the study areas. Adults were sexed, measured to the nearest centimeter, placed in a hatchery truck, and driven to the Highway 75 bridge crossing. We then transferred the adults to large Coleman coolers, placed the coolers on a sled, and pulled the sleds with snowmobiles to the study area. Adults were distributed throughout the two study areas. We monitored spawning weekly and counted the number of redds and fish within the study area. The weirs were removed when we no longer observed active spawning or saw live fish in the study sections. The stream temperature was recorded hourly in the spawning areas with Datapod recorders (Omnidata Corporation, Logan, Utah).

We estimated the number of eggs deposited in each stream by developing a length-fecundity relation from 45 females spawned at Sawtooth Fish Hatchery on April 29, May 3, and May 6. The fish we stocked in Beaver and Frenchman creeks were randomly sorted from the adults spawned at the hatchery on these dates. We measured female fork length to the nearest cm, placed the fertilized eggs in separate incubator trays, and enumerated them with an egg counter. I used regression analysis to estimate fecundity from female length.

Thurow (Intermountain Research Station, Boise, Idaho, unpublished data) estimated that 556 (°C) temperature units (TU) were needed for fry emergence to begin and 722 TU were needed for 95% emergence of hatchery steelhead that spawned naturally in the upper Salmon River. The temperature units accumulated after spawning in Beaver and Frenchman creeks were estimated from the hourly temperature recording as:

$$TU = \sum_{i=1}^{n} \left(\frac{1}{24}\right) h_i \qquad (1)$$

where h_i = hourly temperature (°C) and
n = number of hourly temperatures recorded.

I used Thurow's estimated TU-to-emergence to predict the date of first fry emergence and the date that 95% of the fry had emerged in Beaver and Frenchman creeks.

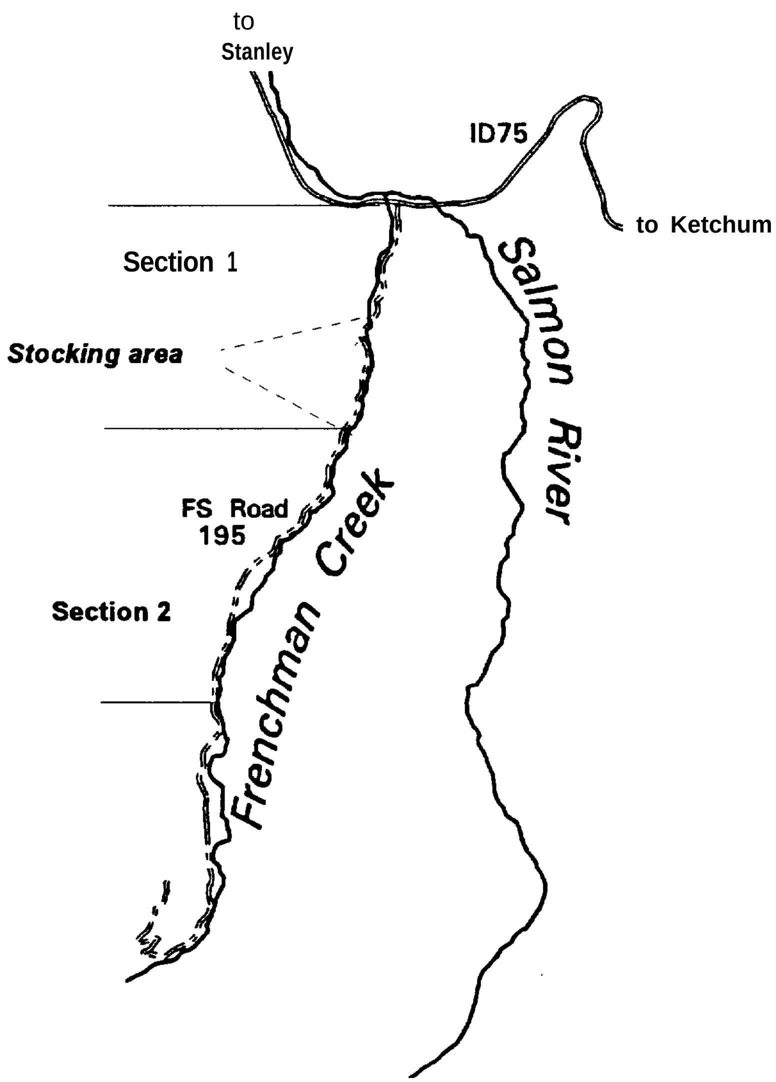


Figure 3. Map of the Frenchman Creek drainage showing the location of the adult stocking area and the stream section boundaries used to estimate population abundance.

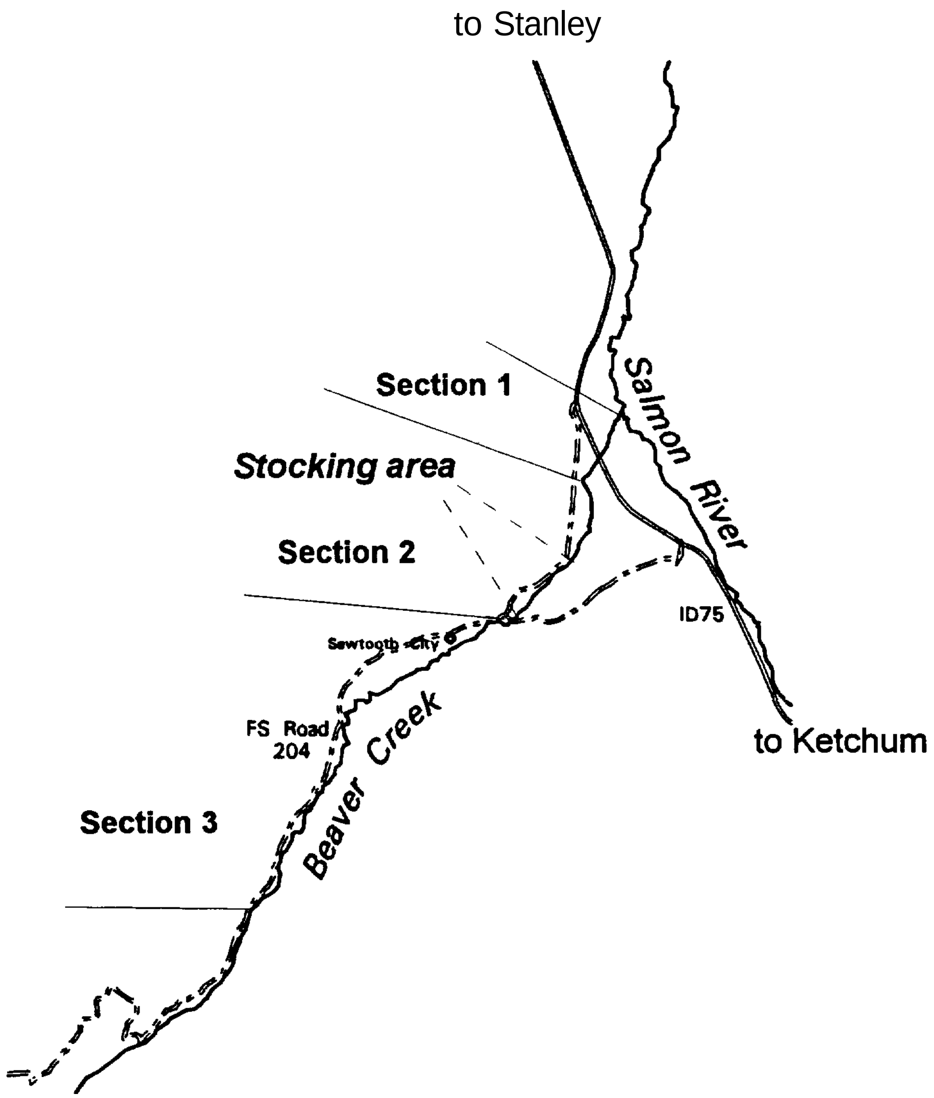


Figure 4. Map of the Beaver Creek drainage showing the location of the adult stocking area and the stream section boundaries used to estimate population abundance.

Fingerling Stocking

We released steelhead fingerlings at three locations in the South Fork Red River on September 1 (Figure 5). We established 15 transects upstream and downstream of the stocking locations (Table 2 and Figure 5) to monitor fingerling movement after release. The most downstream release site was between transects 6 and 7. The furthest upstream release site was between transects 9 and 10 and the middle release location was between transects 7 and 8. The fingerlings were reared at Clearwater Fish Hatchery and were obtained from adults spawned at Dworshak National Fish Hatchery. Before release, crews PIT-tagged 4,987 fish and clipped the right ventral (RV) fin on 45,000 fish. The adipose fin was not clipped on any fish. Hatchery personnel sampled 300 fish on August 25 to obtain mean fork length (mm) and weight (0.1 g) before release.

Because there were some natural steelhead in the South Fork Red River, and we could not observe fin clips on all stocked fingerlings when snorkeling, we only counted steelhead that were < 127 mm when monitoring fish movement after stocking. I established 12 transects in the South Fork Red River and three in tributaries. One tributary transect was located in West Fork Red River, which enters the South Fork upstream of the stocking area, and we put the other two tributary transects in Trapper Creek, which enters the South Fork downstream of the stocking area. We snorkeled all transects and counted the number of juvenile steelhead less than 127 mm prior to stocking, and 7, 14, and 27 days after stocking. Transects l-8 were snorkeled, a fifth time, 35 d after stocking. By mid-October, we did not observe many steelhead in any transect because the water temperature had dropped below 4°C and most steelhead were in the substrate.

We collected 77 marked steelhead on November 3 by electrofishing, and measured fork length and weight. Mean daily growth rate (G) was determined as:

$$G = \frac{(L_2 - L_1)}{D} \tag{2}$$

where L_1 = mean fork length on August 25,
L_2 = mean fork length on November 3, and
D = number of days from release to recapture.

Condition factor (K) of steelhead was calculated before release, and on November 3, as:

$$K = \frac{W\ (100{,}000)}{L^3} \tag{3}$$

where W = weight in grams and
L = fork length in mm.

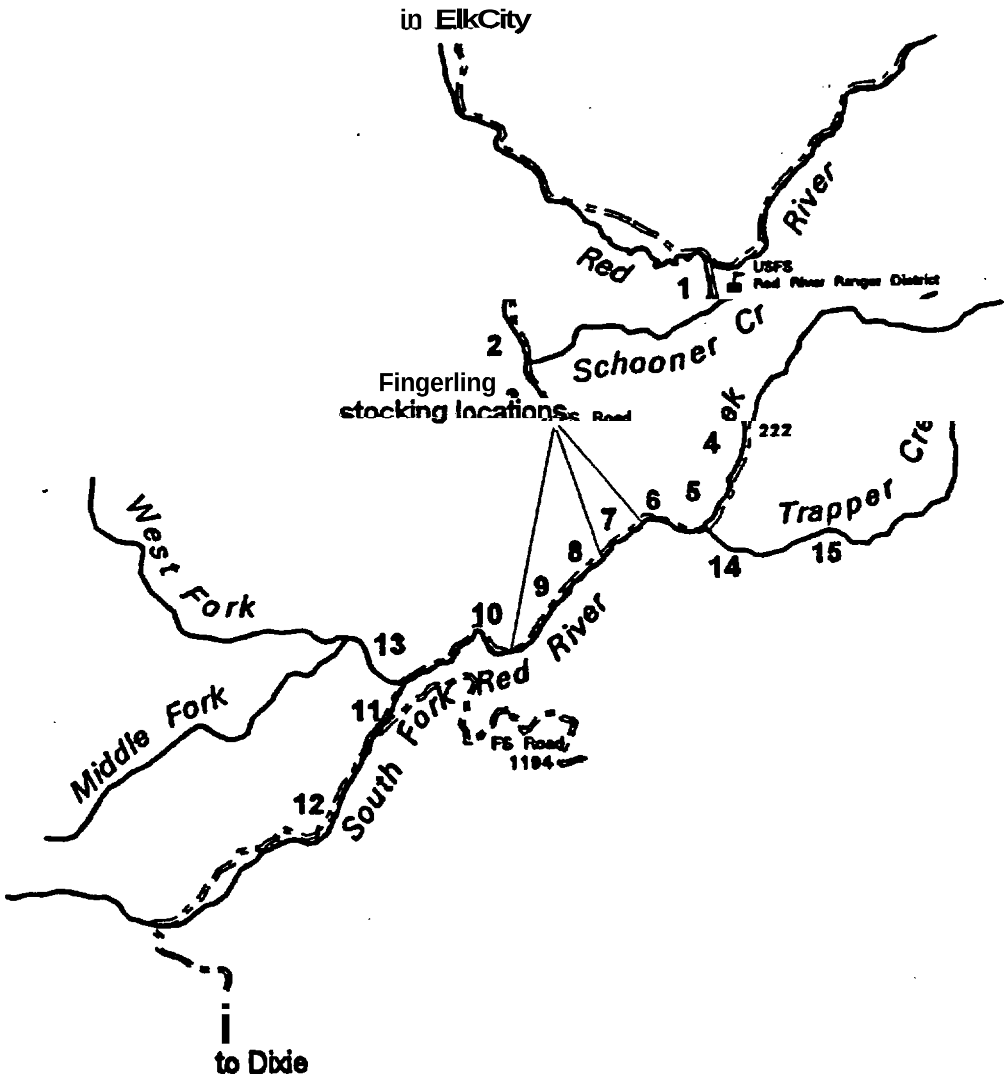


Figure 5. Map of the South Fork Red River drainage showing the location of snorkel sites used to measure dispersal of stocked fingerling steelhead and the stream section boundaries used to estimate population abundance.

Table 2. Length, average widths, habitat type, and distance from the mouth of South Fork Red River of snorkel transects used to monitor fingerling dispersal. For sites 13-l 5, distance is upstream from the tributary mouth with South Fork Red River. Fingerlings were stocked 6.4, 7.4, and 9.8 km upstream of the South Fork Red River mouth.

Site	Stream	Distance from mouth (km)	Length (m)	Average width (mm)	Habitat type
1	South Fork Red River	0.2	37.3	4.8	run/pool
2	South Fork Red River	1.0	38.5	6.1	riffle/run/pool
3	South Fork Red River	2.0	30.5	8.0	run
4	South Fork Red River	3.1	33.4	6.4	run/PW[a]
5	South Fork Red River	4.2	35.0	6.5	run
6	South Fork Red River	5.5	28.9	7.0	run
7	South Fork Red River	6.6	23.2	3.6	run
8	South Fork Red River	7.7	23.4	5.1	run
9	South Fork Red River	8.8	28.0	7.4	run/riffle/pool
10	South Fork Red River	10.0	43.2	4.7	run
11	South Fork Red River	12.0	22.8	3.2	run/riffle
12	South Fork Red River	12.7	20.4	2.9	run/riffle
13	West Fork Red River[b]	0.5	28.6	2.9	run/riffle
14	Trapper Creek'	0.1	22.0	4.3	PW
15	Trapper Creek	1.3	30.0	4.4	PW

a PW = pocket water.
b Enters South Fork Red River about 11.6 km upstream of its mouth.
c Enters South Fork Red River about 4.6 km upstream of its mouth.

Juvenile Abundance

Steelhead supplementation crews snorkeled six streams in the Salmon River drainage, and two in the Clearwater River drainage, to estimate juvenile steelhead abundance. Each stream was divided into sections based on gradient, habitat characteristics, or stream order. We walked the stream and classified the predominant stream habitat every 10 m into pool, run, riffle, and pocketwater (Shepard 1983) prior to snorkeling. The number of snorkel sites for each habitat type was allocated in proportion to its abundance in the stream.

Depending on stream size, one to four snorkelers counted fish in each snorkel site. Each snorkel site was separated by at least one distinct habitat type change from a prior site. Snorkelers estimated the size of juvenile steelhead and resident trout to the nearest inch. After the site was snorkeled, we measured the length and three to six widths of the site to calculate surface area.

Chinook salmon and steelhead parr were aged based on observed size. Chinook salmon parr were counted and classified as age 0 (brood year 92, < 100 mm) or age 1 (brood year 91, > 100 mm). Steelhead parr were classified as: age 1, length 3-5 in (76-l 27 mm); and age 2 + , length >5 in (127 mm). Because steelhead fry (age 0, <75 mm) are indistinguishable from cutthroat trout 0. *clarki* fry, we classified both as trout fry. We did not partition cutthroat trout, bull trout *Salvelinus confluentus,* brook trout *S. fontinalis,* and mountain whitefish *Prosopium williamsoni* into age classes.

Densities (fish per 100 m^2) by habitat type, in each stream section, were calculated for' trout fry, the two age classes of steelhead, chinook salmon, resident trout, and mountain whitefish. The total age 1 and age 2+ steelhead population was estimated for each stream section using the stratified sampling estimates of Scheaffer et al. (1986):

$$N_S = \sum_{i=1}^{4} A_i \overline{d_i} \qquad (4)$$

where:
N_s = population total for section s,
A_i = total surface area, in section s, of habitat type i,
$\overline{d}_i$ = mean steelhead density, in section s, of habitat i, and
i = pool, riffle, run, pocket water.

The total surface area (A_i) of each habitat type in the stream section was calculated as:

$$A_i = L_s p_i w_i \qquad (5)$$

where:
L_s = length of stream section s,
p_i = proportion of habitat i in stream section s, and
w_i = mean width of habitat i in section s.

An approximate 95% confidence interval (CI_s) on the population estimates in the stream section was calculated as:

$$CI_s = 2\sqrt{\sum_{i=1}^{h} A_i^2 \left(\frac{A_i - a_i}{A_i}\right)\left(\frac{s_i^2}{n_i}\right)} \qquad (6)$$

where:
A_i = total surface area of habitat i,
s^2_i = the sample variance of mean steelhead density in habitat i,
a_i = total surface area of habitat i snorkeled in the section,
n_i = number of habitat i sites snorkeled in the section, and
i = pool, run, pocketwater, or riffle habitat.

We treated A_i and a_i as constants when calculating confidence intervals and assumed that the variance was due to differences of densities in each snorkel site, not area measurements. The estimated total abundance of each age class, for the entire stream, was found by summing the estimates of all sections.

Stream Temperatures

I put temperature recorders (Onset Computer Corporation, Pocasset, Massachusetts) in 17 streams in early June (Table 3). The water temperature was recorded every 1.6 h throughout the summer. The data was downloaded in late September and the recorders were reset to measure stream temperature every 3.2 h throughout the winter. The daily mean, maximum, and minimum temperatures were calculated for each stream. We computed the number of temperature units accrued in each stream, from June 15 to September 15, by summing the daily mean temperature. The elevation of each recorder was determined from 7.5 min United States Geological Survey topographic maps. I used regression analysis to determine the relation between elevation and temperature units accrued from June 15 to September 15.

PIT Tagging

Steelhead supplementation crews PIT-tagged juvenile steelhead in Fish Creek in late August. We captured the fish by fly-fishing with size 16 barbless flies. Idaho Supplementation Studies personnel operating screw traps on Red River, Crooked Fork Creek, Marsh Creek, and South Fork Salmon River PIT-tagged wild steelhead captured during the spring (March 1 to June 15) and fall (August 15 to November 15) trapping periods. Idaho Department of Fish and Game personnel operated a weir in Rapid River from September 1 to October 10 to collect migrant bull trout and steelhead. All steelhead > 100 mm captured in the Rapid River weir were PIT-tagged. At all other locations, we tagged steelhead >60 mm. The screw traps were checked daily and the number of steelhead captured was recorded. The size of the fish that were not measured for fork length was estimated to the nearest inch by personnel tending the trap. Fish that were measured were grouped into 5 mm length classes and the length frequency of the migrants was plotted.

Table 3. The number, mean length (cm), and redds built by hatchery adult steelhead released in Beaver and Frenchman creeks. The standard deviation is in parenthesis. NA = not applicable.

Location	Number of males	Number females	Mean male length		Mean female length		Number of redds
Beaver Creek, 4/30	12	10	58	(2)	59	(1)	
Beaver Creek, 5/6	7	5	59	(4)	57	(2)	5"
Frenchman Creek	12	10	59	(3)	58	(2)	9
Sawtooth Fish Hatchery	-	45			58	(3)	NA

' From both stocking dates.

We followed PIT tagging procedures outlined for chinook salmon in Kiefer and Forester (1991) and the PIT Tag Steering Committee (1992). At the screw traps, PIT tagging data was recorded using a PIT Tagging Station (Biomark Inc., Boise, Idaho). A maximum of 20 juveniles was anesthetized with MS-222 at one time. PIT tagging equipment was sterilized with 70% ethanol solution to reduce disease transfer between fish. Tagged juveniles were held 4 to 24 hours to observe mortality and tag rejection then released throughout the area where they were captured.

All steelhead captured in Fish Creek were measured for fork length to the nearest millimeter and weighed to the nearest 0.1 g. At the screw traps and weir, a subsample of steelhead was measured for fork length to the nearest millimeter and weighed to the nearest 0.1 g. Condition factor (equation 3) was calculated for all fish that were weighed and measured. Analysis of Variance (ANOVA) for unbalanced designs was used to test for differences in length and condition factor among streams. When significant differences were detected, the Tukey-Kramer HSD test was used for all pairwise comparisons among the streams (SYSTAT 1992).

Smolt travel time of fish detected at Lower Granite Dam and the percent detected at all dams with a smolt detector was calculated for Crooked Fork Creek, Marsh Creek, and South Fork Salmon River. Because many of the steelhead we tagged were Parr, we assumed that only fish > 140 mm at tagging were smolts. Kiefer (unpublished data, IDFG) has documented that few steelhead < 140 mm migrate to the ocean based on six years of PIT-tagging in the upper Salmon River and Crooked River. The detected fish and travel time (in days) data was downloaded from the PTAGIS database. Travel time was converted to kilometers traveled per day from the release site to Lower Grate Dam. For each stream, I calculated the median travel time to Lower Granite Dam and the confidence interval with confidence 295%. Confidence intervals for streams with <25 detections at Lower Granite Dam were determined using the binomial distribution. If there were ≥25 detections at Lower Granite Dam, I used the normal approximation to a binomial distribution (Zar 1984, Steinhorst et al. 1988) to calculate confidence intervals.

Adult and Juvenile Steelhead Scale Samples

Scales were obtained from naturally produced adults trapped in the Lemhi River and Clear Creek during the spring. We obtained scales of age 1 + juveniles from Fish Creek from the United States Fish and Wildlife Service. Scales were taken from both sides of the fish from the preferred area (MacLellan 1987). This area is located just above the lateral line posterior of a vertical line drawn from the posterior end of the dorsal fin. All scales were mounted on gummed paper and pressed in acetate prior to ageing.

RESULTS

Adult Steelhead Collectron and Outplants

Collection and Stocking

Because of poor river conditions and low abundance of wild steelhead, we only captured three wild steelhead. We did not stock any wild adults for the Objective 1 experiments. We stocked hatchery adults in Frenchman and Beaver creeks to refine our protocols for future years and to evaluate the reproductive success and long-term fitness of outplanted hatchery fish. The stream temperature was recorded hourly in both streams, beginning May 4, to predict date of fry emergence.

Ten females and 12 males were stocked in Frenchman Creek on April 29, 1993. The average length of males and females was 59 cm and 58 cm, respectively (Table 3). On May 4, we counted eight redds and four live fish in the study area. On May 11, we counted a ninth redd and two live fish in the study section. Crews removed the weirs on May 11.

Ten females and 12 males were stocked in Beaver Creek on April 30, 1993. The average length of males and females was 58 cm and 59 cm, respectively (Table 3). Stream flow increased the week after stocking and fish could swim around the downstream weir when we checked it on May 4. We counted one live fish (near the downstream weir) and no redds in the study section. Crews walked Beaver Creek from the weir downstream to its mouth and counted one redd and one live fish, both about 50 m downstream of the weir. On May 6, we stocked five females and seven males in the study section after repairing the weir. On May 1 1, we counted 12 live fish and 3 redds in the study area. The stream flow had increased and fish were able to swim around the weir. Once again, personnel walked Beaver Creek, from the study site downstream, to its confluence with the Salmon River. We counted one live fish 70 m downstream of the weir, and one additional redd, 45 m downstream of weir, in this section. We planned a final redd count, on May 17, but were unable to see the substrate because of high stream flow. The weir was removed on May 17.

Egg Deposition

Female length was not a reliable indicator of fecundity (Figure 6), although the regression of length on fecundity was significant ($p = 0.002$). Length explained about 20% of the variation in fecundity. Many of the fish used in the analysis had partially spawned before entering the hatchery weir. Nearly all females were 54 to 60 cm in length, yet the number of eggs per fish ranged from 1,709 to 5,416. The mean fecundity of females spawned at Sawtooth Fish Hatchery was 3,854 ($n = 45$, 95% CI ± 297). It is likely that some of the females we stocked in Frenchman and Beaver creeks were partially spawned since we sorted

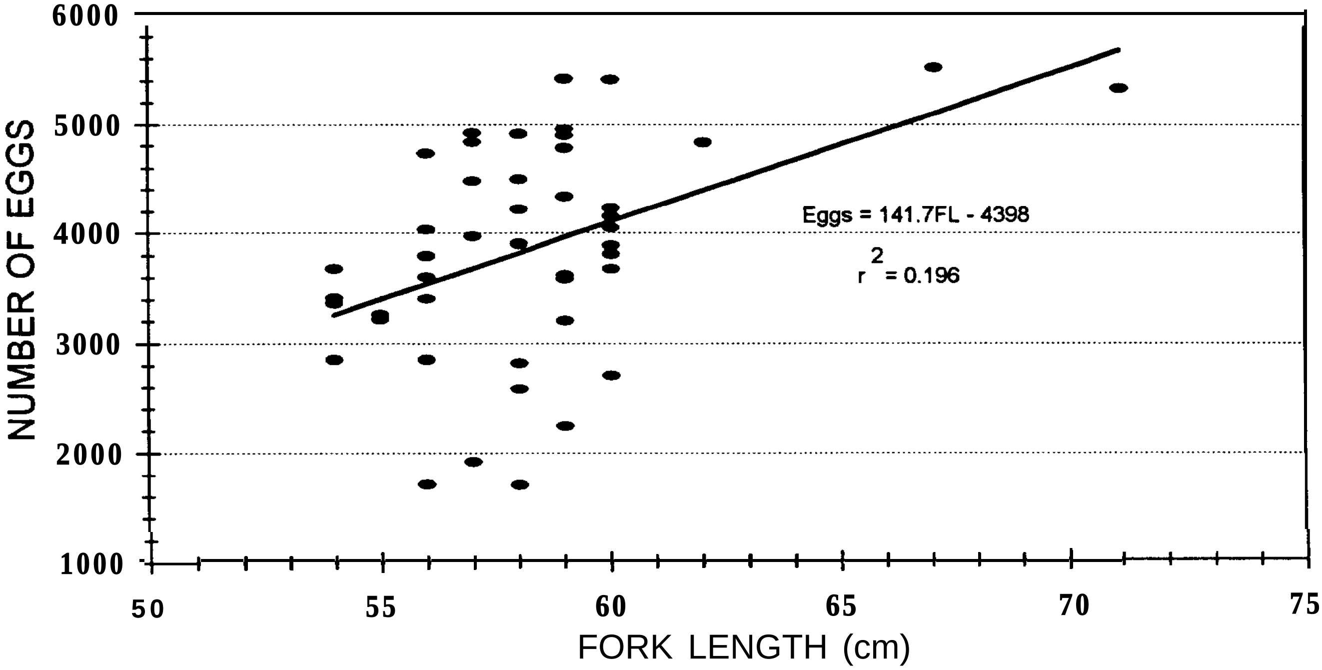


Figure 6. The relation between female steelhead fork length (FL) spawned at Sawtooth Fish Hatchery and fecundity.

these fish from the same group used for the regression analysis. Because of the weak relation between length and fecundity, I used the mean fecundity to estimate egg deposition in Beaver and Frenchman creeks. I estimated the maximum egg deposition (and 95% Cl) was 38,540 (±2,970) and 57,810 (±4,455) in Frenchman and Beaver creeks, respectively. If one female makes one redd, the number of eggs actually deposited, based on redd counts, was 34,686 (± 2,673) and 19,270 (± 1,485) in Frenchman and Beaver creeks, respectively.

Fry Emergence

I used May 4 and May 11 as the starting dates for temperature unit accumulation in Frenchman and Beaver creeks, respectively. In Frenchman Creek, the predicted emergence date was July 29, with 95% emergence by August 20 (Figure 7). In Beaver Creek, the predicted emergence began on August 6 and was 95% complete on August 23 (Figure 7). Steelhead Supplementation Study crews snorkeled Beaver and Frenchman creeks, July 23 to 25, and counted no steelhead fry in Beaver Creek and only one fry in Frenchman Creek. We did not quantify fry production in either stream; however, fry were more abundant in Beaver Creek than Frenchman Creek based on a qualitative assessment of the streams on September 9-10. Fry length, in both streams, on September 9 to 10, ranged from 35-50 mm based on visual observation.

Fingerling Stocking

On September 1, we stocked South Fork Red River with about 50,000 marked steelhead parr that averaged 74 mm fork length. On November 3, an IDFG crew collected 77 RV and PIT-tagged juveniles. The daily growth rate after release was 0.0557 mm/d. There were significant increases (t-test, p ~0.0001) in mean length from 74 mm to 77 mm, mean weight from 3.6 g to 4.7 g, and mean condition factor from 0.907 to 1.0, after release into the stream (Table 4).

We were unable to detect much movement of the hatchery fingerlings out of the stocking area after release. The largest number of fish was counted September 8, seven days after release. The number of fish in each transect declined on all subsequent snorkel dates except the October 6 count in transect 9 (Figure 8). In transects 1 to 4, parr numbers did not increase after stocking (Figure 8a). An increase from 2 to 10 parr was observed in transect 5 a week after stocking, but we did not observe any increase from pre-release steelhead counts on subsequent sampling dates (Figure 8b). In transect 6, the number of steelhead increased from zero pre-release, to 37 on September 8, but then declined about 12 fish (Figure 8b). Transects 7 to 9 were within the stocking area, had the largest increase from the pre-release steelhead count, and had the highest steelhead numbers throughout the fall (Figures 8b and 8c). The upstream release site was between transects 9 and 10 and we observed movement upstream into transect 10 after stocking. In transect 10, the pre-release steelhead count was two, increased to 57 fish on September 8, and remained about 30 fish into October (Figure 8c). We did not observe any increase in the number of steelhead from the pre-release count in transects 11 and 12, and only counted one steelhead in transects 13 to 15 during the monitoring period. We concluded that there was no significant movement of the stocked steelhead upstream of the West Fork Red River, into Trapper Creek, or downstream of transect 5. No marked fingerlings were captured in a screw trap that operated near the mouth of Red River (about 23 km downstream of the stocking area) until November 15.

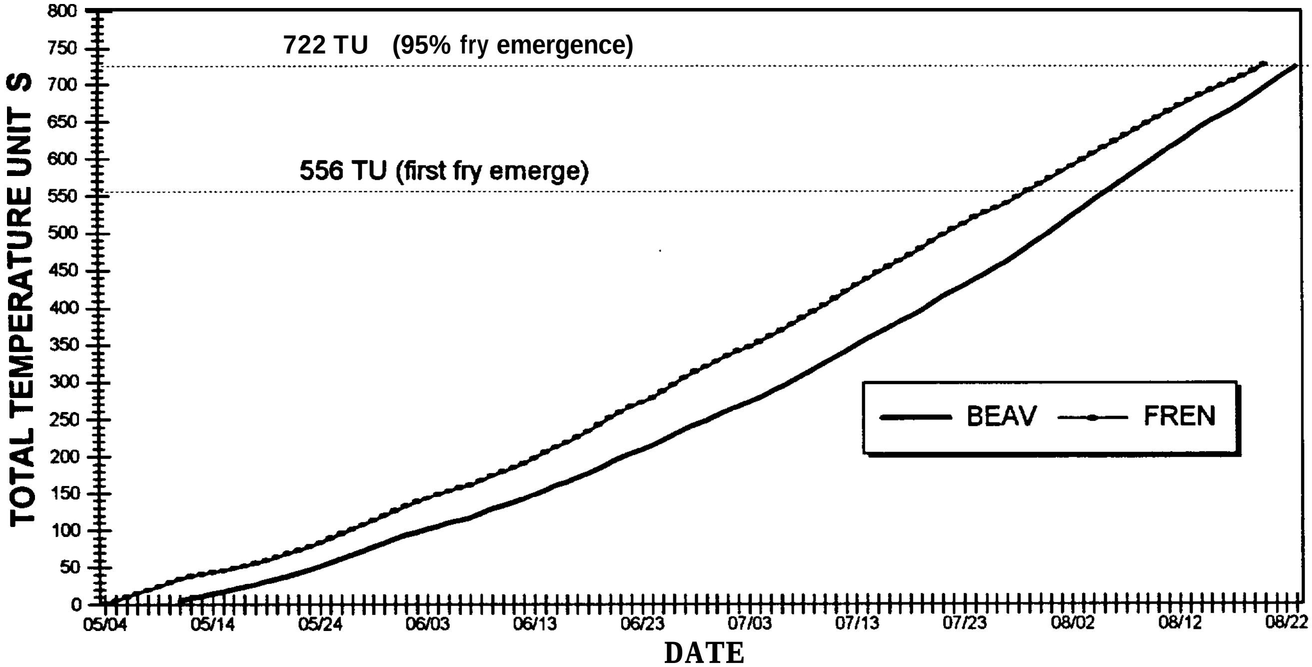


Figure 7. The amount of temperature units (C°) accrued in Beaver (BEAV) and Frenchman (FREN) creeks from the estimated steelhead spawning date.

Table 4. The mean fork length, weight, and condition factor (K) of hatchery fingerlings before and after their release in South Fork Red River. The standard deviation is in parenthesis. Fish were stocked on September 1. Length, weight, and K are all significantly different between the two groups (t - test, p c 0.0001).

Group	Date	N	Mean fork length (mm)	Mean weight (g)	Mean K
Pre-release	8/25	300	74 (5)	3.6 (0.7)	0.907 (0.1291
Post-release	11/3	77	77 (6)	4.7 (1.3)	1 .o (0.19)

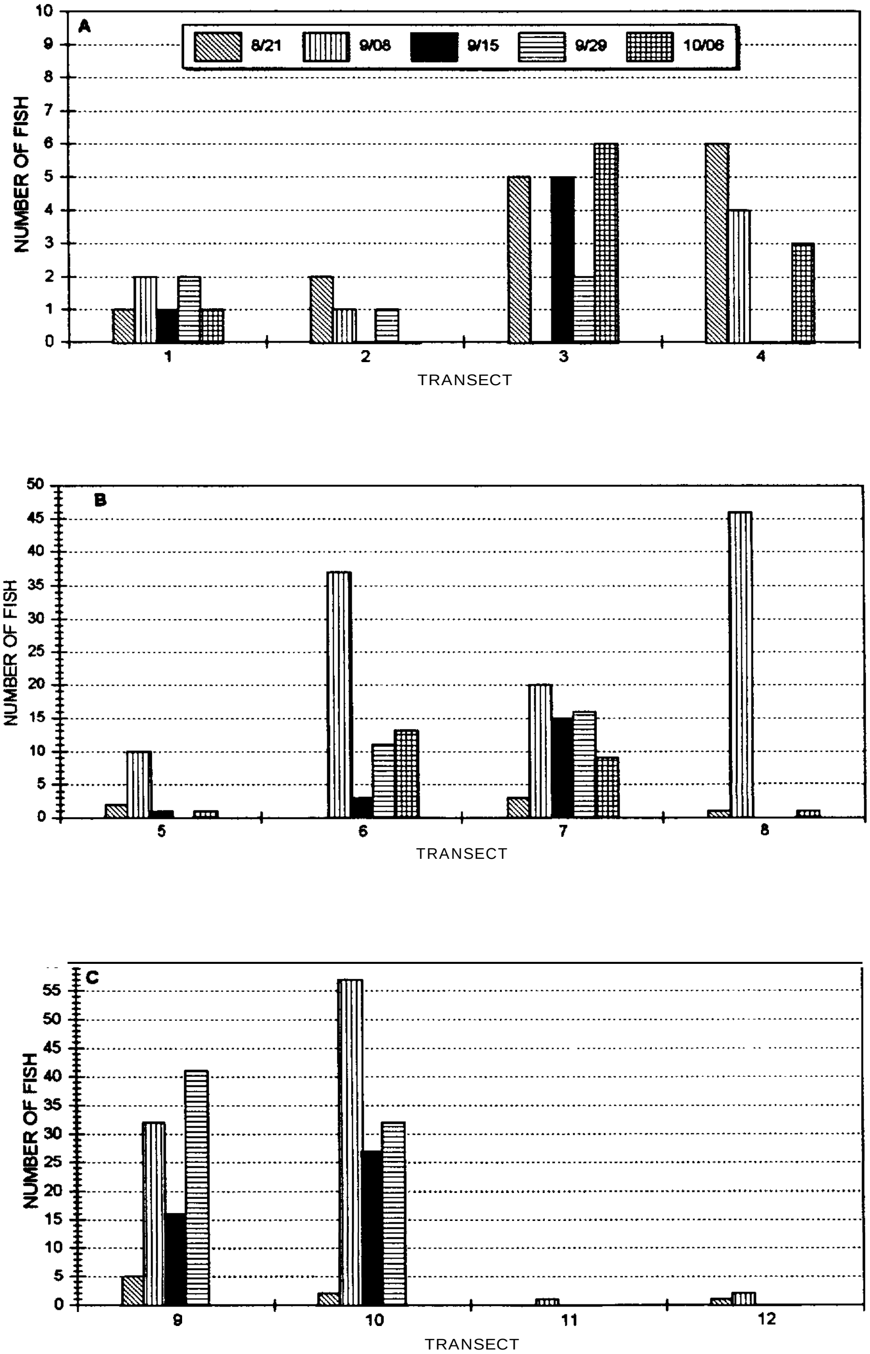


Figure 8. The number of steelhead < 127 mm counted in snorkel sites prior to and after hatchery fingerling steelhead (mean length 73.5 mm) were stocked in the South Fork Red River on September 1. The fish were stocked between transects 6 and 7, transects 7 and 8, and transects 9 and 10. (A) Transects 1 - 4; (B) Transects 5 - 8; (C) Transects 9 -12.

Habitat Survey

The dominant stream habitat was classified every 10 m in Frenchman, Beaver, and West Pass creeks, and the South Fork Red River. In Germania Creek, we classified the habitat in an upper meadow section, but not from the mouth upstream to the meadow. The stream habitat in the remaining East Fork Salmon River tributaries and Fish Creek, was not classified. Based on our survey, we divided the streams into sections that reflected gradient, habitat, or stream order differences.

Salmon River Drainage

Frenchman Creek was partitioned into two sections: Section 1 from the mouth, upstream about 3.1 km, and Section 2, from Section 1, upstream another 3.1 km. In Section 1, runs (75.5%) are the dominant habitat, pools are small and infrequent, beaver dams are absent, and the gradient is steeper than Section 2. Beaver dams are present in Section 2, pools are more frequent and larger, and the gradient lessens (Table 5).

Beaver Creek was partitioned into three sections: Section 1, from the mouth, upstream about 1.3 km, to an irrigation diversion; Section 2, from the irrigation diversion, upstream about 2.9 km; and Section 3, which extends about 8.4 km further upstream. Section 1 is dewatered during the summer. In Section 2, runs are the dominant habitat type, beaver dams are absent, and pools are infrequent. Section 3 contains many beaver dams, and the largest proportion of pool habitat in the stream (Table 5).

The boundary of Sections 1 and 2, in West Pass Creek, is, Roaring Creek, a major tributary. The proportion of pocketwater and pool habitat is similar in both sections, but run habitat is more prevalent in Section 2. The stream flow is reduced in the lower 1.5 km of Section 1 during the summer, due to an irrigation diversion.

In Germania Creek, we only classified habitat from the mouth of Chamblerlain Creek downstream 3 km. From this downstream boundary, to its mouth, Germania Creek is confined to a narrow steep canyon and contains primarily pocketwater and plunge pool habitat.

Clearwater River Drainage

The boundary of Sections 1 and 2, in South Fork Red River, is Trapper Creek. Section 2 continues about 6.9 km upstream, to the mouth of West Fork Red River. The proportion of run and pool habitat is similar in the two sections, but pocketwater habitat is more prevalent in Section 1 (Table 5).

We did not measure the proportion of habitat types in Fish Creek. However, the section we snorkeled, from the mouth upstream to Hungry Creek, is predominately pocketwater habitat with a gradient >2%.

Table 5. The percentage of pool, run, pocketwater, and riffle habitat in streams snorkeled by steelhead supplementation crews in 1993. Percentages may not add to 100 due to rounding error. Section 1 begins at the mouth of each stream. In Germania Creek, we only surveyed from Chamberlain Creek downstream 3.0 km.

Stream	Section	Approximate length (km)	Pool	Run	Pocketwater	Riffle
Frenchman Creek	1	3.1	7.1	75.5	2.3	15.1
	2	3.1	24.4	65.1	1.0	9.5
	Total	6.2	15.7	70.4	1.6	12.3
Beaver Creek	1	2.9	8.8	73.1	5.3	21.5
	2	8.4	32.3	56.1	2.1	29.8
	3			47.9		17.7
	Total	12.6	24.1	52.4	2.6	20.9
West Pass Creek	1	2.3	3.4	19.7	10.3	66.5
	2	4.7	4.7	32.8	9.4	53.0
	Total	7.0	4.3	28.5	9.7	57.5
S.F. Red River	1	4.7	4.1	39.6	20.1	36.2
	2	6.9	10.0	45.2	14.1	30.7
	Total	11.6	7.6	43.0	16.5	32.9
Germania Creek	2	3.0	5.4	24.3	25.3	44.8

Juvenile Steelhead Abundance

Mean Densities of Steelhead Parr

The combined age 1 and age 2+ steelhead densities in Frenchman Creek ranged from 12.85 fish/100 m^2 in Section 1 pool habitat, to 0.29 fish/l00 m^2 in Section 2 riffle habitat (Table 6). The combined age 1 and age 2+ steelhead density in Beaver Creek ranged from 8.67 fish/l00 m^2 in Section 2 pool habitat, to zero in pocketwater and riffle habitat in Sections 2 and 3 (Table 6). We snorkeled Beaver Creek before Section 1 was dewatered due to irrigation. Snorkelers counted no steelhead in most sites in Beaver and Frenchman creeks. Of the 61 snorkel sites in Frenchman Creek, we counted age 1 steelhead in 20 sites and age 2 + steelhead in 21 sites. Of the 65 sites we snorkeled in Beaver Creek, we counted age 1 steelhead in ten sites and age 2+ steelhead in nine sites.

The combined age 1 and age 2+ steelhead densities were usually less than 1 fish/l00 m^2 in the four East Fork Salmon River tributaries. All steelhead were observed in the lower 2 km of these streams. Bull trout was the only species we counted that was more than 2 km upstream of the mouth in each tributary (Table 7). Snorkelers observed juvenile steelhead infrequently in these streams. For example, in West Pass Creek, we snorkeled 46 sites and only observed age 1 fish in two sites and age 2+ fish in six sites.

The highest steelhead densities were in Fish Creek, a tributary of the Lochsa River. The combined age 1 and age 2+ steelhead densities in Fish Creek ranged from 33.33 fish/l00 m^2 in pool habitat, to 11.05 fish/l00 m^2 in pocketwater habitat. In the South Fork Red River, a tributary of the South Fork Clearwater River, combined age 1 and age 2+ steelhead densities ranged from 5.75 fish/l00 m^2 in Section 2 pool habitat, to 0.74 fish/l00 m^2 in Section 1 riffle habitat (Table 8). The densities in the South Fork Red River were estimated July 8 and 9, prior to the hatchery fingerling stocking.

Steelhead Parr Population Estimates

I estimated the total juvenile steelhead population in Beaver Creek, Frenchman Creek, West Pass Creek, and the South Fork Red River. We did not complete the habitat survey in Fish Creek and the East Fork Salmon River tributaries (other than West Pass Creek), and therefore were unable to estimate the population abundance in these streams. The estimated age 1 and age 2+ steelhead population ranged from a high of 1,453 (±646) in the South Fork Red River, to a low of 134 fish (± 124) in West Pass Creek. Beaver and Frenchman creeks had nearly identical population estimates: 483 (± 712) fish in Beaver Creek and 480 (±267) fish in Frenchman Creek (Table 9).

Table 6. Mean fish density (fish/l 00 m²), by habitat type, in Beaver and Frenchman creeks snorkeled by steelhead supplementation crews in 1993. AREA = total surface area snorkeled in m²; NUMBER = number of sites snorkeled of each habitat type; FRY = all trout <65 mm; SHI = juvenile steelhead 65-127 mm; SH2 + = juvenile steelhead > 127 mm; CHO = age 0 chinook salmon; CUTT = all cutthroat trout; BULL = all bull trout; BROOK = all brook trout; WHITE = all mountain whitefish; TOTAL = total salmonid density.

STREAM	HABITAT	AREA	SECTION	NUMBER	DATE	FRY	SHI	SH2 +	CHO	CUTT	BULL	BROOK	WHITE	TOTAL
Beaver Creek	Pool	66	1	1	7/23-25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Beaver Creek	Riffle	294	1	4		0.00	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.42
Beaver Creek	Run	582	1	8		0.00	1.70	1.09	0.00	0.68	0.00	2.90	0.00	6.37
Beaver Creek	Pool	146	2	4	7/23-25	0.00	3.81	4.86	0.00	1.39	0.00	13.65	0.00	23.71
Beaver Creek	PW	296	2	3		0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.50
Beaver Creek	Riffle	386	2	7		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Beaver Creek	Run	1,259	2	17		0.00	0.34	0.59	0.00	0.00	0.00	4.79	0.00	5.72
Beaver Creek	Pool	306	3	6	7/23-25	0.00	0.00	0.00	0.00	0.00	0.00	2.50	0.00	2.50
Beaver Creek	Riffle	320	3	5		0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.33
Beaver Creek	Run	721	3	10		0.00	0.55	0.39	0.00	0.00	0.00	0.19	0.00	1.13
Frenchman Creek	Pool	107	1	6	7/24-25	0.00	4.64	8.21	0.00	2.14	0.00	11.27	0.00	26.92
Frenchman Creek	PW	155	1	4		0.00	1.03	5.27	0.00	0.00	0.00	0.00	0.00	7.10
Frenchman Creek	Riffle	235	1	7		0.00	0.53	0.00	0.00	0.00	0.00	0.39	0.00	0.92
Frenchman Creek	Run	762	1	23		0.17	2.22	2.42	0.00	0.08	0.52	2.29	0.00	8.09
Frenchman Creek	Pool	100	2	3	7/24-25	0.00	0.00	1.52	13.96	3.05	0.00	1.52	0.00	20.06
Frenchman Creek	Riffle	178	2	6		0.00	0.00	0.29	0.00	0.00	0.00	3.39	0.00	3.97
Frenchman Creek	Run	635	2	12		0.00	0.23	0.38	12.45	0.00	0.00	8.65	0.00	21.72

Stream Temperatures

The recorder in Crooked Fork Creek was pulled from the water and placed on the bank in mid-July by an unknown person. I placed the recorder back in the stream on October 4. All other recorders were undisturbed. The temperature data from Crooked Fork Creek was omitted from analysis. Streams in the Clearwater River drainage accumulated more temperature units than those the Salmon River drainage (Figure 9). There was a significant ($p < 0.001$, $r^2 = 0.61$) relation between elevation and temperature units accumulated. Graphs of the daily mean, maximum, and minimum temperature in each stream can be found in Appendix 1.

PIT-Tagging

Spring Trapping, March 15 - June 15

One thousand forty two of the 2,607 steelhead caught in the four screw traps were PIT-tagged during the spring. We collected 910 steelhead (450 tagged) at the South Fork Salmon River trap, 854 steelhead (493 tagged) at the Crooked Fork Creek trap, 603 steelhead (99 tagged) at the Marsh Creek trap, and 240 steelhead (none tagged) at the Red River trap (Table 10). Fish were not weighed at Crooked Fork Creek, therefore condition factors were not calculated.

There was a significant difference in mean fork length among the streams ($F = 560.4$, $df = 3$, $p < 0.001$). All pairwise comparisons among the streams were significant ($p \leq 0.001$). The mean lengths of migrants were: 166 mm in Crooked Fork Creek, 149 mm in Red River, 98 mm in Marsh Creek, and 88 mm in the South Fork Salmon River. Assuming that steelhead > 140 mm are smolts, then 85% of the steelhead trapped in Crooked Fork Creek were smolts (Figure 10a). Smolts made up 75% of the catch in Red River, 8% in Marsh Creek, and 7% in the South Fork Salmon River (Figures 11a, 12a, and 13a). In Marsh Creek and the South Fork Salmon River about 78% of the steelhead we trapped were < 100 mm.

Significant differences in mean condition factor were detected among the streams ($F = 16.1$, $df = 2$, $p < 0.001$). The pairwise comparisons revealed that condition factor was significantly different between Red River and South Fork Salmon River ($p < 0.001$). All other pairwise comparisons were not significant, although the test between Marsh Creek and South Fork Salmon River approached significance ($p = 0.083$). The mean condition factors of migrants were: 1.0 in Red River, 1.077 in South Fork Salmon River, and 1.038 in Marsh Creek.

Fish began moving downstream earlier in Red River and Crooked Fork Creek than in Marsh Creek and South Fork Salmon River (Figure 14a). In Crooked Fork Creek, Red River, and Marsh Creek, a majority of the captured fish were caught during brief periods of time. The sharpest migration spike occurred in Crooked Fork Creek from April 29 to May 3, when 51% of the steelhead were captured. We collected 50% of the steelhead in Marsh Creek from May 1 to 10, and 47% of the steelhead in Red River from April 16 to May 1 (Figure 14a).

Table 7. Mean fish density (fish/l 00 m^2), by habitat type, in East Fork Salmon River tributaries snorkeled by steelhead supplementation crews in 1993. AREA = total surface area snorkeled in m^2; NUMBER = number of sites snorkeled of each habitat type; FRY = all trout < 65 mm; SHI = juvenile steelhead 65-127 mm; SH2 + = juvenile steelhead > 127 mm; CHO = age 0 chinook salmon; CUTT = all cutthroat trout; BULL = all bull trout; BROOK = all brook trout; WHITE = all mountain whitefish; TOTAL = total salmonid density.

STREAM	HABITAT	AREA	SECTION	NUMBER	DATE	FRY	SHI	SH2 +	CHO	CUTT	BULL	BROOK	WHITE	TOTAL
Germania Creek	Pool	422	1	6	8/8-l 0	0.00	0.40	2.49	0.00	0.00	1.62	0.00	0.23	4.74
Germania Creek	PW	839	1	5		0.00	0.52	0.66	0.00	0.00	0.97	0.00	0.27	2.43
Germania Creek	Riffle	1,042	1	8		0.00	0.62	0.98	0.00	0.08	0.31	0.10	0.15	2.25
Germania Creek	Run	840	1	9		0.00	0.11	1.62	0.00	0.22	0.68	0.00	0.47	3.10
Germania Creek	Pool	186	2	4	8/8-l 0	0.00	0.00	0.00	0.00	0.00	18.11	0.00	0.00	18.11
Germania Creek	PW	682	2	5		0.00	0.00	0.00	0.00	0.00	2.32	0.00	0.00	2.32
Germania Creek	Riffle	1,419	2	10		0.00	0.00	0.00	0.00	0.00	2.62	0.00	0.00	2.62
Germania Creek	Run	720	2	6		0.00	0.00	0.00	0.00	0.00	3.34	0.00	0.00	3.34
SF EF Salmon River	PW	177	1	1	8110	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SF EF Salmon River	Riffle	1,495	1	9		0.00	0.00	0.00	0.00	0.00	1.16	0.00	0.12	1.28
SF EF Salmon River	Run	515	1	7		0.00	0.00	0.00	0.00	0.00	4.95	0.00	0.34	5.29
West Pass Creek	Pool	54	1	1	815-6	0.00	0.00	3.70	0.00	0.00	0.00	0.00	0.00	3.70
West Pass Creek	PW	351	1	1		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
West Pass Creek	Riffle	957	1	7		0.00	0.00	0.81	0.00	0.00	0.81	0.00	0.07	1.69
West Pass Creek	Run	775	1	4		0.00	0.14	0.64	0.09	0.00	0.00	0.00	0.29	1.16
West Pass Creek	Place	182	2	3	8/5-6	0.00	0.00	0.00	0.00	0.00	4.88	0.00	0.00	4.88
West Pass Creek	PW	369	2	4		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
West Pass Creek	Riffle	1,613	2	17		0.00	0.00	0.00	0.00	0.00	1.46	0.00	0.00	1.46
West Pass Creek	Run	935	2	9		0.00	0.14	0.00	0.00	0.00	2.60	0.00	0.00	2.74
WF EF Salmon River	Pool	15	1	1	8/9	0.00	0.00	0.00	0.00	0.00	13.14	0.00	0.00	13.14
WF EF Salmon River	PW	652	1	6		0.00	0.00	0.24	0.00	0.00	2.79	0.00	0.00	3.03

Table 8. Mean fish density (fish/l 00 m^2), by habitat type, in Clearwater River tributaries snorkeled by steelhead supplementation crews in 1993. AREA = total surface area snorkeled in m^2; NUMBER = number of sites snorkeled of each habitat type; FRY = all trout <65 mm; SHI = juvenile steelhead 65-l 27 mm; SH2 + = juvenile steelhead > 127 mm; CHO = age 0 chinook salmon; CUTT = all cutthroat trout; BULL = all bull trout; BROOK = all brook trout; WHITE = all mountain whitefish; TOTAL = total salmonid density.

STREAM	HABITAT	AREA	SECTION	NUMBER	DATE	FRY	SHI	SH2 +	CHO	CUTT	BULL	BROOK	WHITE	TOTAL
Fish Creek	Pool	572	1	3	7/10-13	3.58	14.03	19.30	0.00	1.87	0.00	0.00	0.00	38.78
Fish Creek	PW	10,287	1	17		2.01	6.05	5.00	0.00	0.35	0.00	0.00	0.00	13.41
Fish Creek	Run	2,585	1	9		4.43	**11.26**	8.75	0.00	1.30	0.00	0.00	0.00	25.74
Hungry Creek	PW	821	1	2	7113	0.82	3.63	3.00	0.00	0.00	0.00	0.00	0.00	7.46
Hungry Creek	Run	224	1	1		0.00	13.83	12.05	0.00	0.89	0.00	0.00	0.00	26.78
SF Red River	Pool	127	1	2	7/8-9	0.00	1.83	1.83	0.00	1.83	0.00	1.10	0.00	6.60
SF Red River	PW	893	1	5		0.00	1.46	0.97.	0.00	0.67	0.00	0.00	0.00	3.11
SF Red River	Riffle	858	1	6		0.00	0.74	0.00	0.00	0.09	0.00	0.00	0.14	0.97
SF Red River	Run	1,135	1	7		0.00	1.85	2.53	0.00	1.21	0.00	0.00	0.04	5.64
SF Red River	Pool	70	2	2	7/8-9	0.00	0.00	5.75	0.00	7.14	0.00	2.90	0.00	15.79
SF Red River	PW	495	2	3		0.00	0.79	0.14	0.00	0.14	0.00	0.00	0.00	1.07
SF Red River	Riffle	1,064	2	9		0.00	0.59	0.09	0.00	0.86	0.00	0.09	0.08	1.72
SF Red River	Run	1,250	2	10		0.00	0.73	0.25	0.00	3.73	0.00	0.04	0.00	4.75

Table 9. Population totals for age 1 and age 2+ steelhead and the approximate 95% Cl on the population estimate (in parenthesis).

Stream	Section	Aae 1	Age 2+
Beaver Creek	1	87 (94)	52 (97)
Beaver Creek	2	71 (61)	102 (84)
Beaver Creek	3	100 (194)	71 (137)
Beaver Creek	ALL	258 (394)	225 (318)
Frenchman Creek	1	184 (69)	220 (89)
Frenchman Creek	2	16 (30)	60 (79)
Frenchman Creek	ALL	200 (99)	280 (168)
West Pass Creek	1	5 (9)	117 (90)
West Pass Creek	2	12 (23)	0 (0)
West Pass Creek	ALL	17 (34)	117 (90)
South Fork Red River	1	486 (196)	453 (195)
South Fork Red River	2	254 (138)	160 (117)
South Fork Red River	ALL	740 (334)	713 (312)

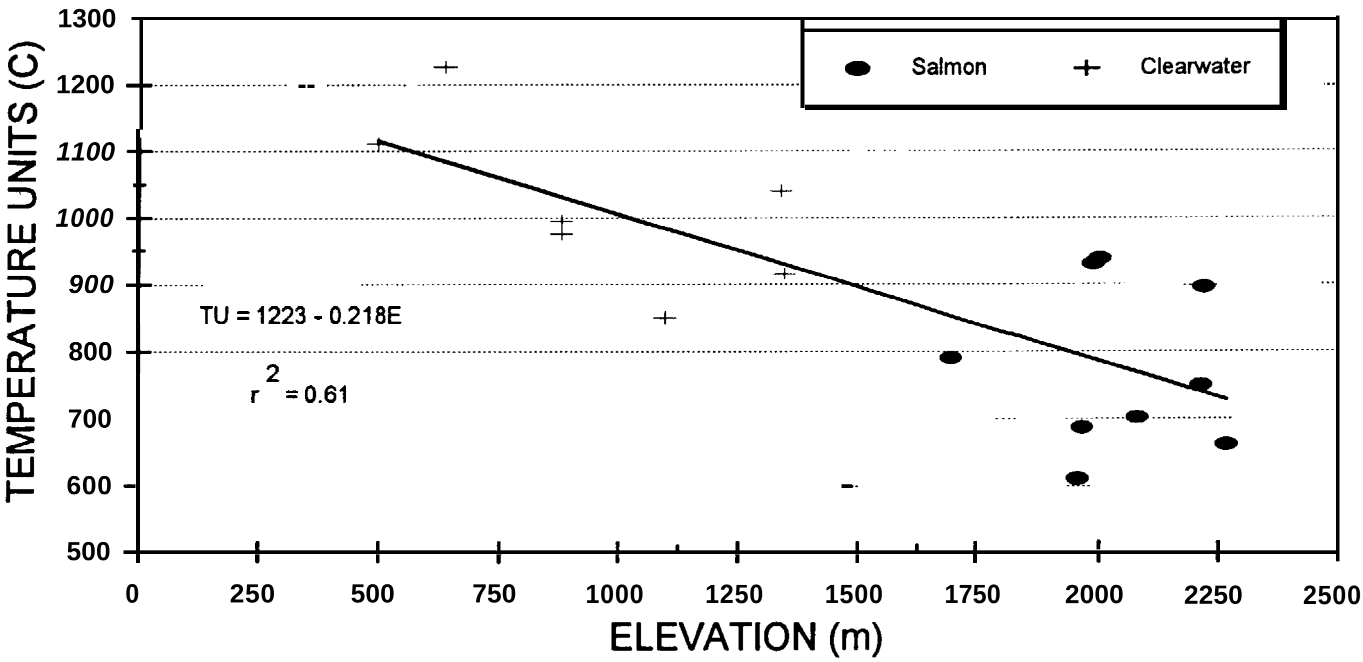


Figure 9. The relation between elevation (E) and temperature units (TU) accrued from June 15 to September 15 in tributaries of the Salmon and Clearwater rivers' drainages.

Table 10. The number of juvenile steelhead that were captured and PIT-tagged in 1993. Sample size (N) for length and condition factor (K) statistics is given. The standard deviation from the mean is shown in parenthesis.

Site	Number collected	Number PIT-tagged	Mean length mm	Median length (mm)	Mean length K	N length	N K
<u>Spring March 15-June 15</u>							
Crooked Fork Creek	a54	493	166 (34)	175		493	0
Red River	240	0	149 (29)	153	1 .ooo (0.171)	196	136
South Fork Salmon River	910	450	88 (26)	79	1.077 (0.13)	457	448
Marsh Creek	603	99	98 (41)	a2	1.038 (0.147')	174	70
<u>Summer - August 23 and 74</u>							
Fish Creek	396	393	138 (23)	137	0.977 (0.091)	396	396
<u>Fa11 - August 15-November 15</u>							
Crooked Fork Creek	294	283	154 (43)	167		284	0
Red River	224	170	151 (44)	150	0.995 (0.13)	170	125
South Fork Salmon River	643	542	143 (40)	140	0.981 (0.141)	542	448
Marsh Creek	303	156	117 (35)	119	0.973 (0.09)	223	156
Rapid River"	284	284	174 (20)	172	1.062 (0.097)	284	256

[a] Steelhead < 100 mm were not measured, weighed, or PIT-tagged.

There was no pronounced spike in the number of fish trapped in the South Fork Salmon River during the trapping period. The number of steelhead caught daily remained fairly constant throughout the trapping period. Unlike the other three rivers, we did not observe an asymptote in the number of steelhead caught in late May and early June.

Steelhead Smolt Travel Time and Detections at Dams

There were 300 detections at Lower Granite, Little Goose, Lower Monumental, and McNary dams of PIT tagged smolts from Crooked Fork Creek. Mean length (at the time of tagging) of the detected smolts was 180 mm (sd = 14) and the minimum length was 144 mm. If we assume that all fish > 140 mm captured at the trap were smolts, then 72% of the tagged smolts were detected at the dams (Figure 10). The median travel time to Lower Granite Dam (n = 215) for the Crooked Fork River smolts was 41 km/d (Figure 15) with a 95% confidence interval of: 36.12 km/d < 41 km/d < 42.63 km/d.

Only nine fish were detected at Lower Granite, Little Goose, Lower Monumental, and McNary dams from the Marsh Creek and the South Fork Salmon River traps. Most of the fish caught in these traps were less than 140 mm and were probably not actively migrating smolts. We tagged 45 and 55 fish > 140 mm in Marsh Creek and South Fork Salmon River, respectively. For the South Fork Salmon River, the mean length (at the time of tagging) of the detected smolts was 167 mm (sd = 18 mm), minimum length detected was 116 mm, and the median travel time and 95% confidence interval to Lower Granite Dam (n = 8) was 24.13 km/d < 26.7 km/d < 45.6 km/d. For Marsh Creek, the mean length (at tagging) of the detected smolts was 149 mm (sd = 14 mm), minimum length detected was 145 mm, and median travel time and 95% confidence interval to Lower Granite Dam (n = 8) was 19.94 km/d < 39.3 km/d < 45.6 km/d (Figure 15).

Summer Tagging

We PIT-tagged 393 juvenile steelhead in Fish Creek on August 23 and 24. The mean length of the fish was 138 mm (sd = 23 mm), median length was 137 mm, and the mean condition factor was 0.977 (sd = 0.091).

Fall Trapping, August 15 to November 15

Fish were collected at the four screw traps used during the spring, and at a temporary weir in Rapid River. The Rapid River weir operated from September 1 to October 15. The Rapid River fish were omitted from the length, condition factor, and migration timing analysis because fish were not trapped after October 15, and steelhead < 100 mm were not measured or tagged. We began trapping about August 15, and ceased trapping at all sites by November 15. We collected 1,746 steelhead and PIT-tagged 1,435, at the five sites during the fall (Table 10). Fish were not weighed at Crooked Fork Creek, therefore condition factor was not calculated for this stream.

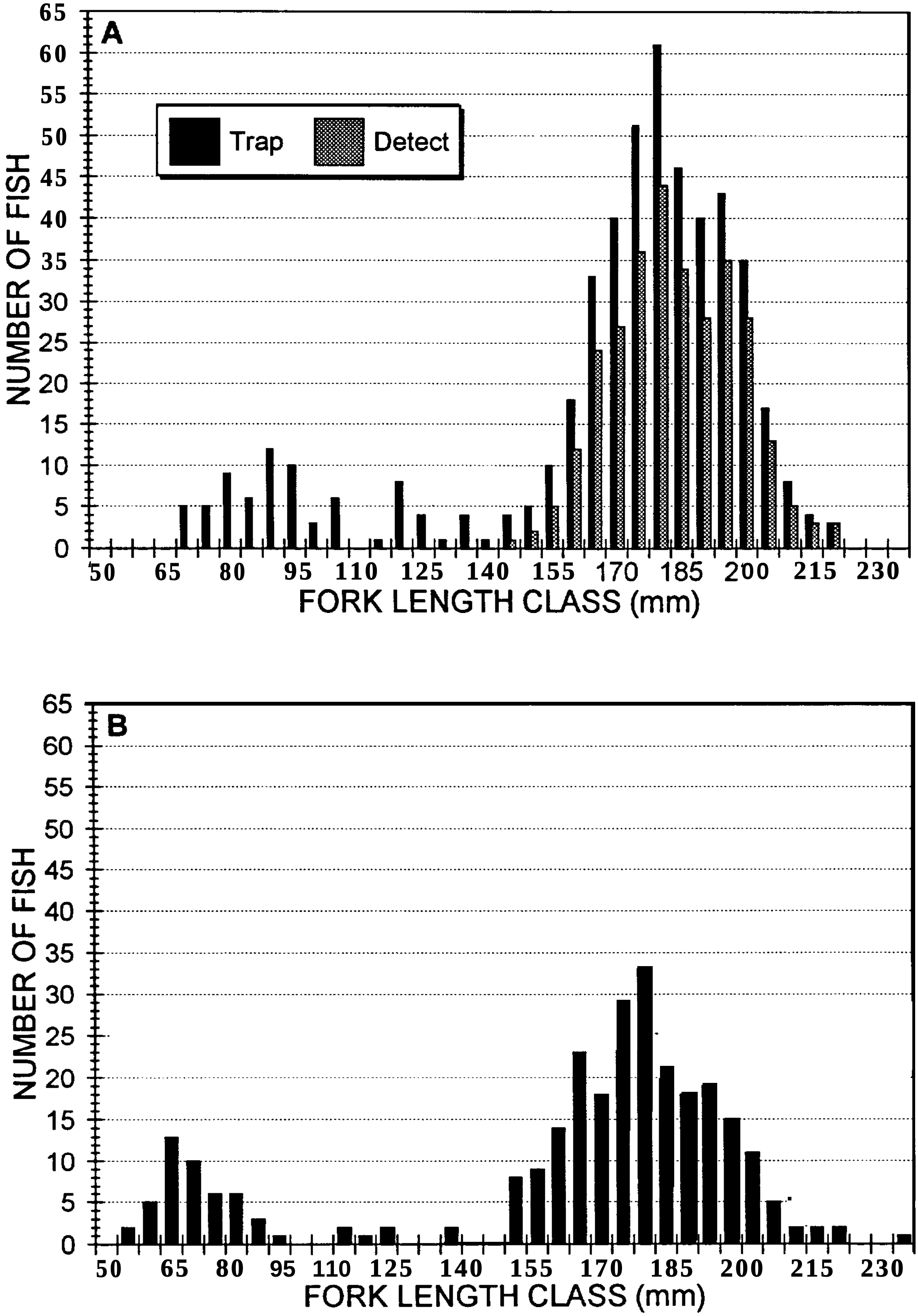
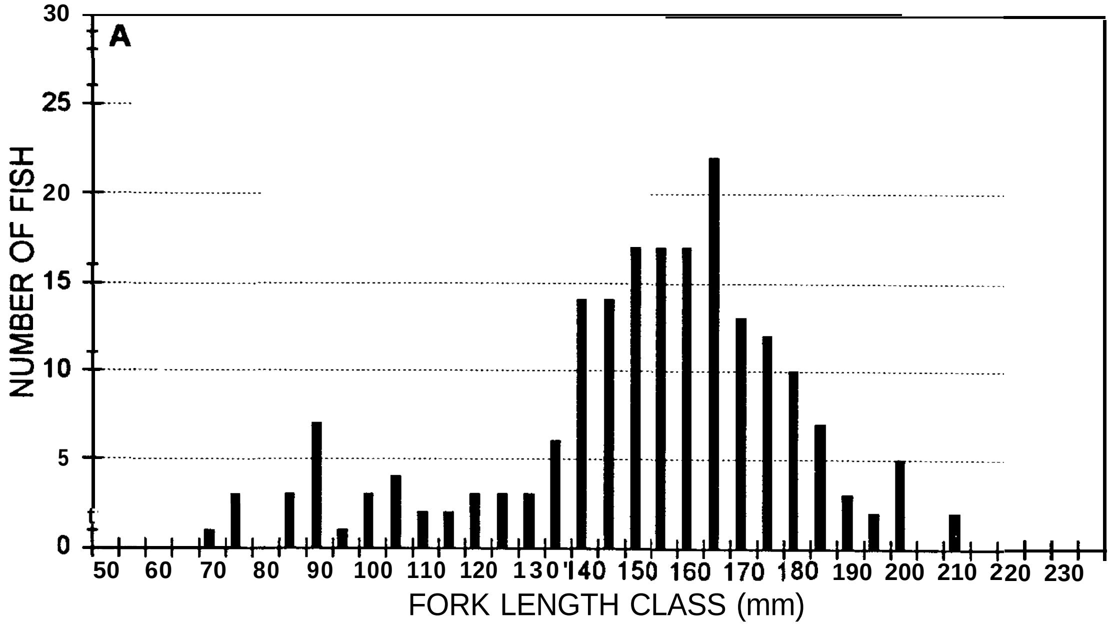


Figure 10. Length frequency of Crooked Fork Creek steelhead caught in the screw trap and of the PIT tagged smolts detected at Snake River dams. (A) March 15 to June 15; (B) August 15 to November 15.



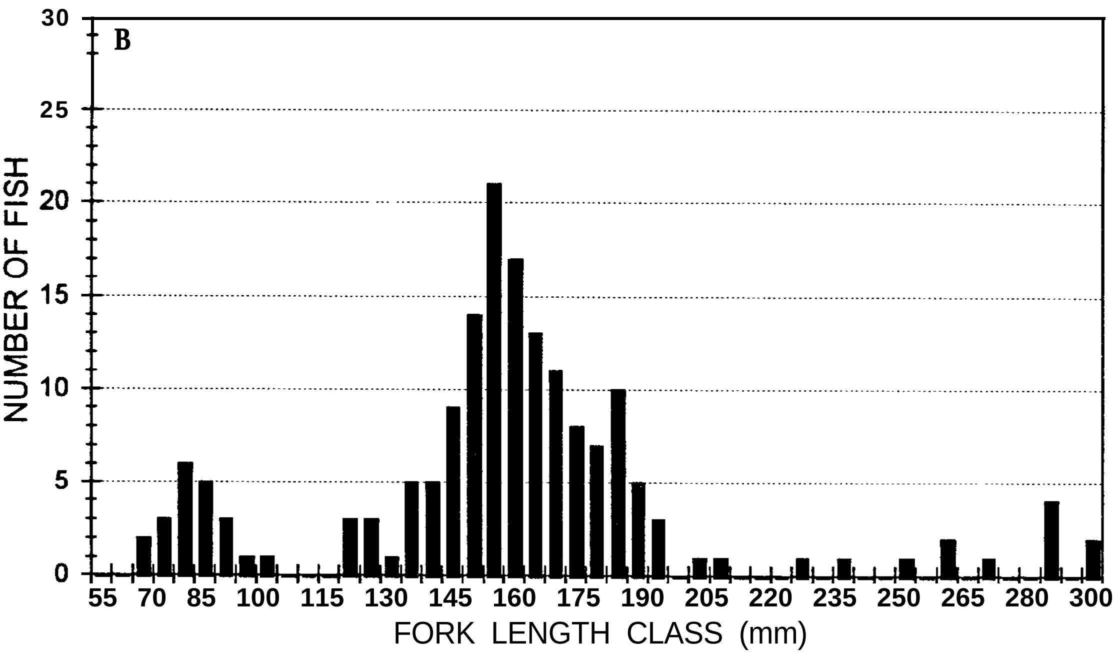
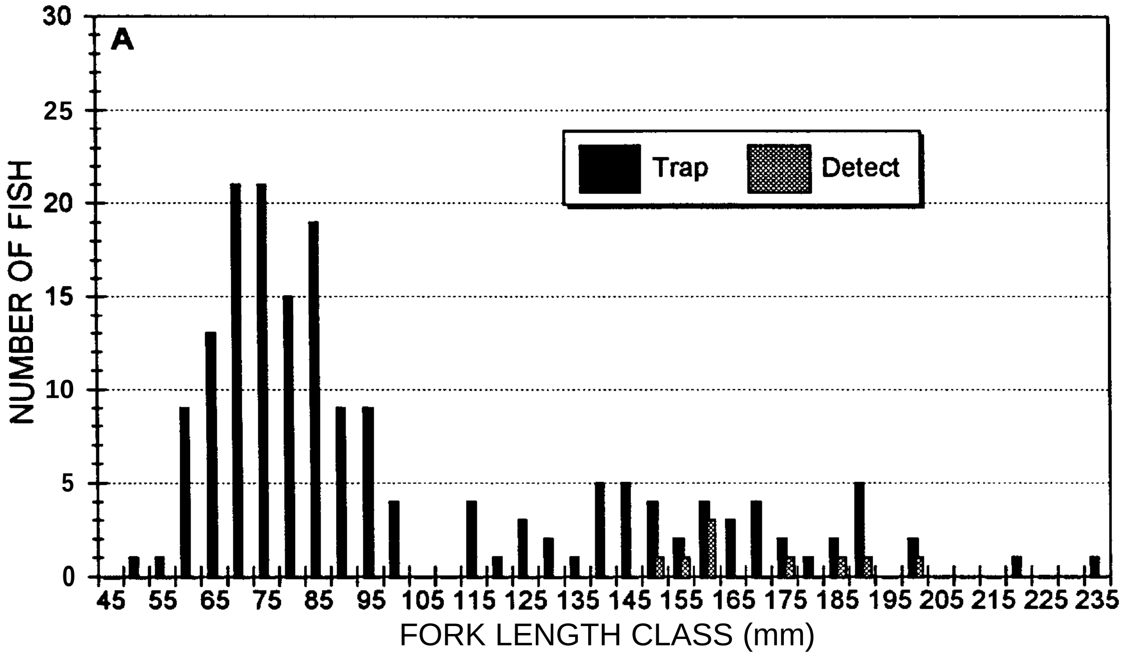


Figure 11. Length frequency of Red River steelhead caught in the screw trap. (A) March 15 to June 15; (B) August 15 to November 15.



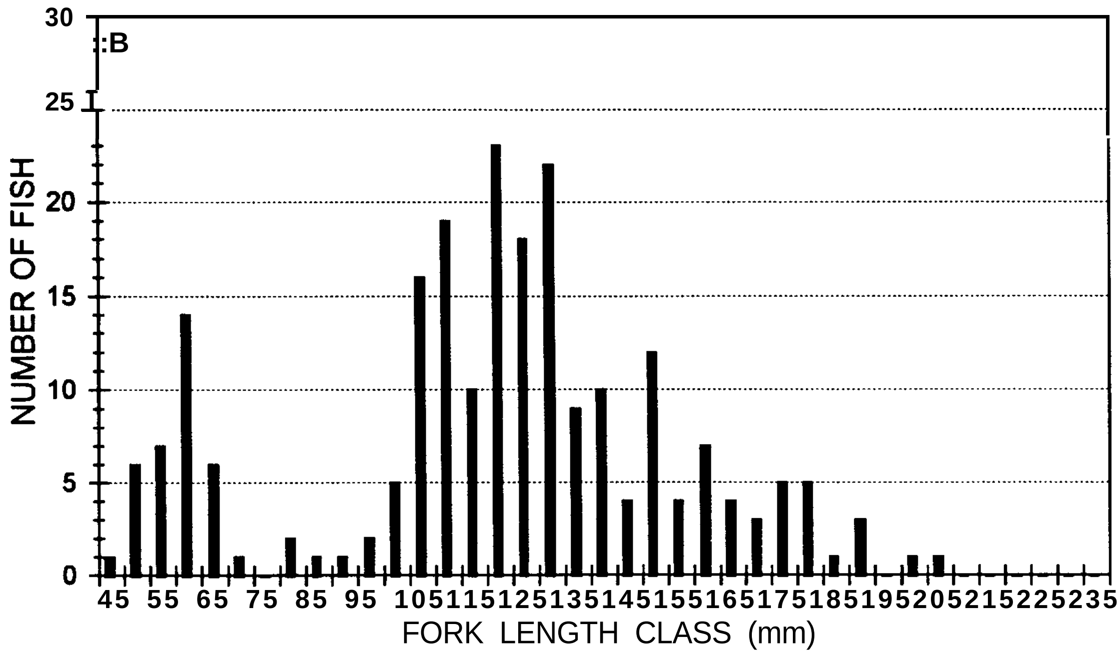
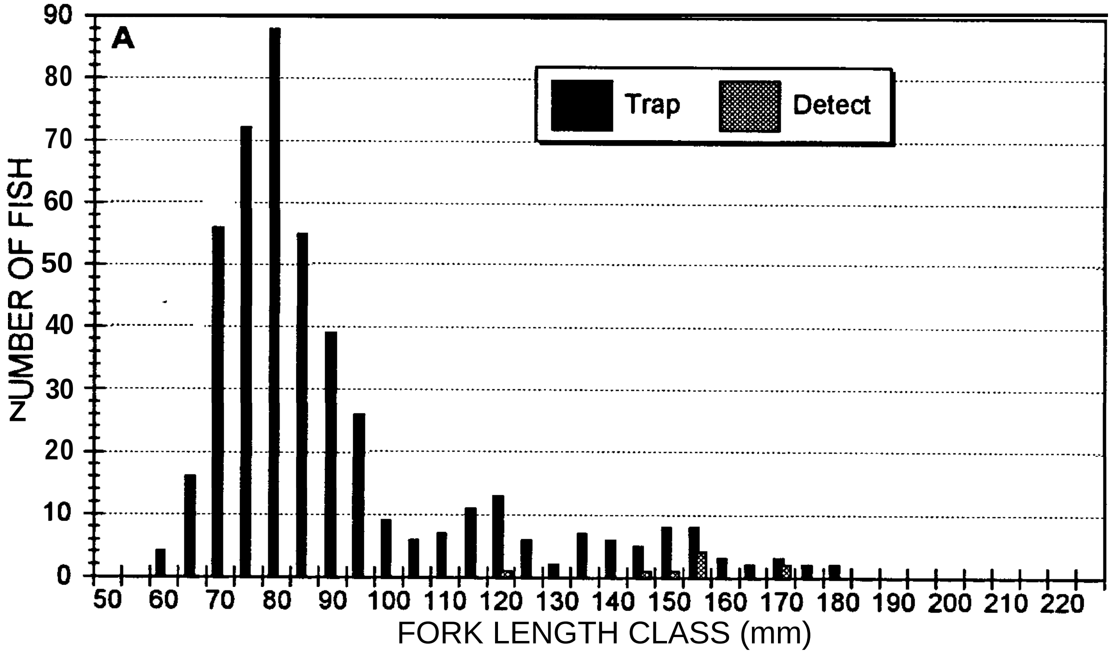


Figure 12. Length frequency of Marsh Creek steelhead caught in the screw trap and of the PIT tagged smolts detected at Snake River dams. (A) March 15 to June 15; (B) August 15 to November 15.



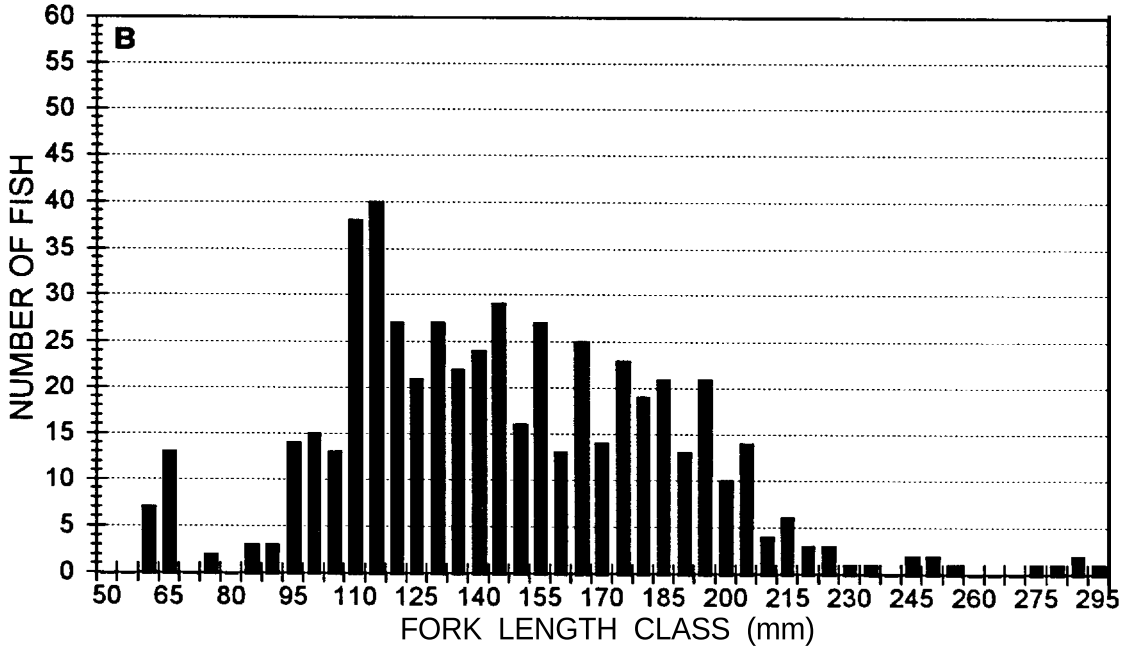


Figure 13. Length frequency of South Fork Salmon River steelhead caught in the screw trap and of the PIT tagged smolts detected at Snake River dams. (A) March 15 to June 15; (B) August 15 to November 15.

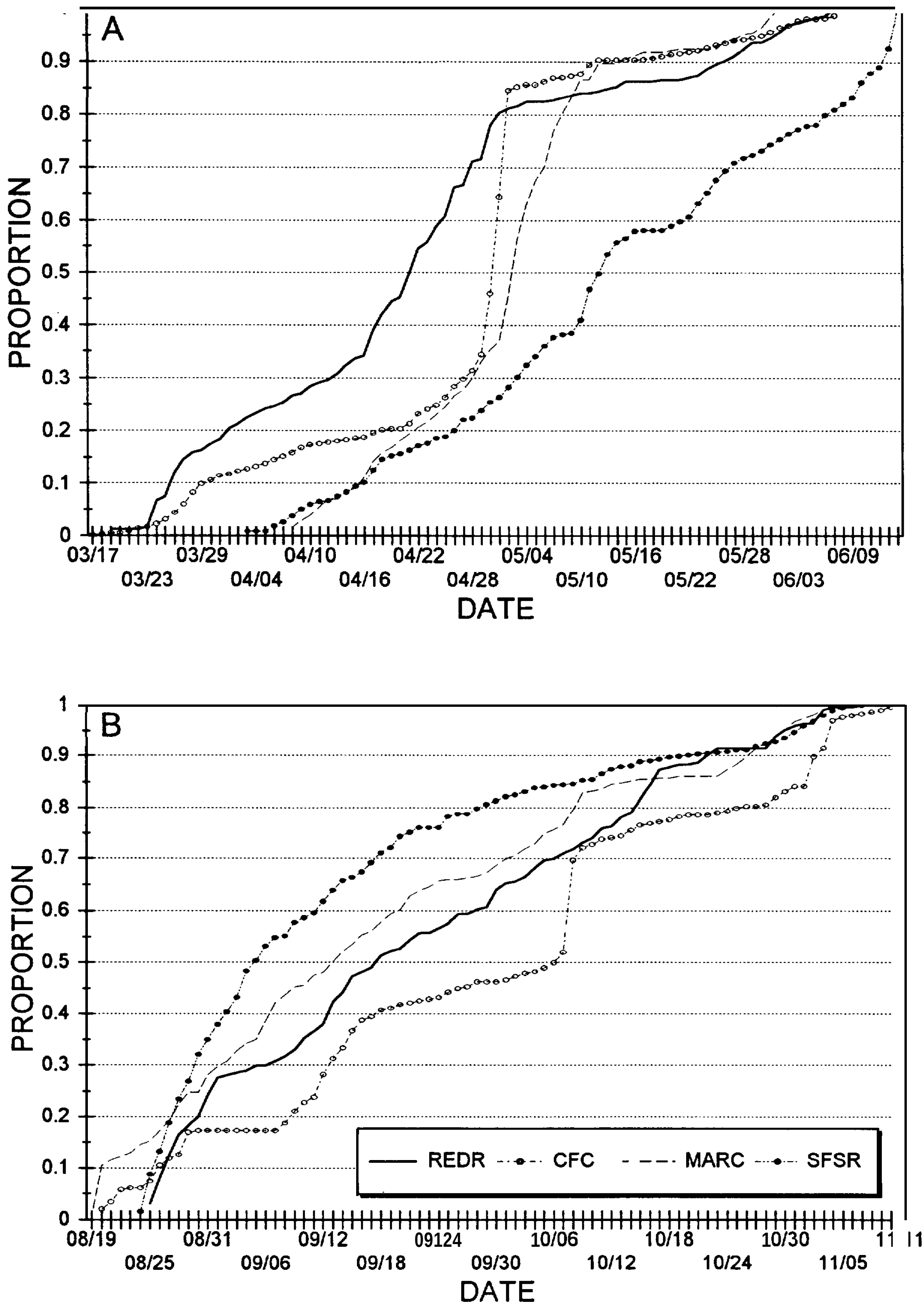


Figure 14. The cumulative proportion of the total number of migrants that were captured on a given date at the screw traps. REDR = Red River; CFC = Crooked Fork Creek; MARC = Marsh Creek; SFSR = South Fork Salmon River. (A) Spring trapping period. (B) Fall trapping period.

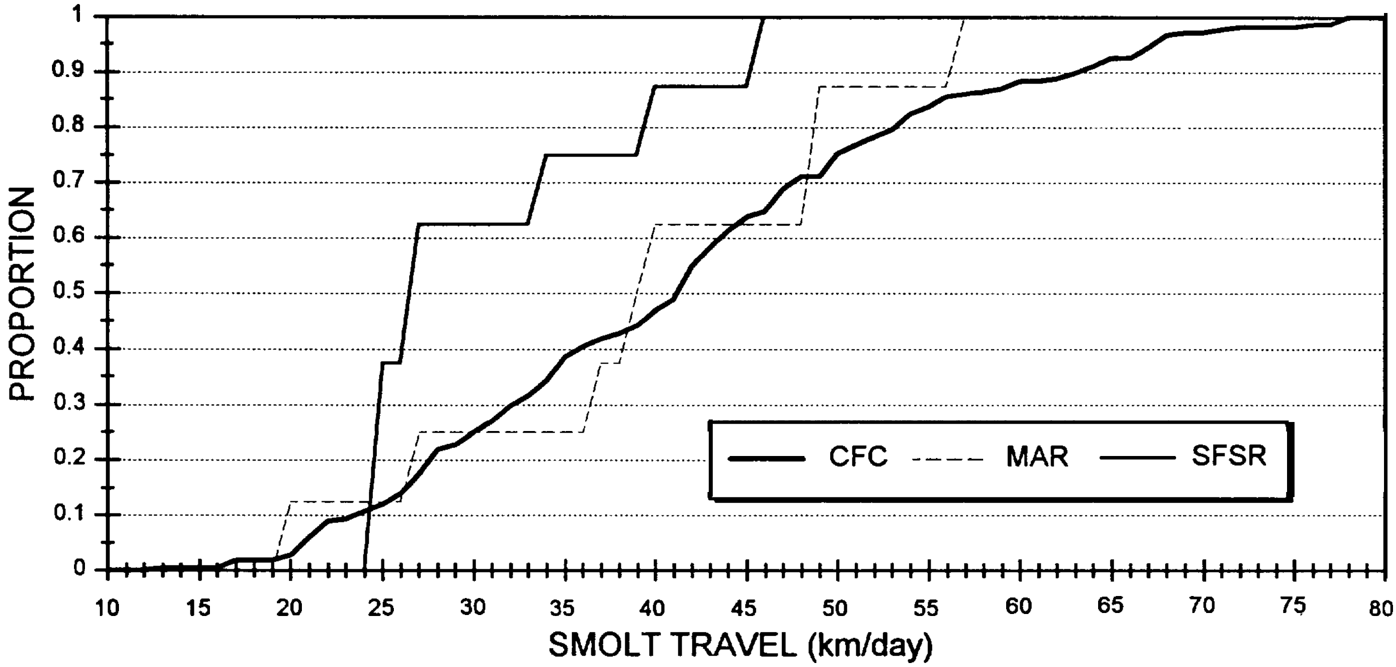


Figure 15. The cumulative distribution of smolt travel time (km/day) from release at the screw trap to detection at Lower Granite Dam. CFC = Crooked Fork Creek, n = 215; MAR = Marsh Creek, n = 8; SFSR = South Fork Salmon River, n = 8.

There were significant differences in the mean length of the fish trapped among the streams ($F = 40.7$, df = 3, $p < 0.001$). Crooked Fork Creek, Red River, and the South Fork Salmon River fish were significantly ($p < 0.001$) larger than Marsh Creek fish. Also, Crooked Fork Creek fish were significantly ($p < 0.001$) larger than South Fork Salmon River fish. The mean length of the migrants was 154 mm in Crooked Fork Creek, 151 mm in Red River, 143 mm in the South Fork Salmon River, and 117 mm in Marsh Creek.

In Crooked Fork Creek, the length of migrants had a bimodal distribution (Figure 10b). Fish > 140 mm made up 61% of the total catch. Fish < 100 m made up 16% of the total catch and 3% were between 100 mm and 140 mm in length.

The steelhead lengths in Red River were bimodally distributed (Figure 11 b). Fish > 140 mm made up 76% of the total catch. Fish < 100 mm made up 12% of the total catch and 10% were between 100 mm and 140 mm.

In Marsh Creek, steelhead > 140 mm in length made up 22% of the total trapped. Twenty-two percent of the fish were < 100 mm and 56% were between 100 mm and 140 mm (Figure 12b).

In the South Fork Salmon River, steelhead > 140 mm in length made up 49% of the total trapped. Eleven percent of the steelhead were < 100 mm and 40% were between 100 mm and 140 mm (Figure 13b).

There was not a significant difference in condition factor among the streams ($F = 0.96$, df = 2, $p = 0.375$). The mean condition factor of the migrants was 0.995 in Red River, 0.961 in the South Fork Salmon River, and 0.973 in Marsh Creek.

Fish migrated out of the South Fork Salmon River and Marsh Creek sooner than Red River and Crooked Fork Creek (Figure 14b). There were no sharp increases in the number of fish trapped in Red River, Marsh Creek, or South Fork Salmon River during the trapping period. There were two spikes, and each one accounted for about 20% of the total number of fish trapped, in Crooked Fork Creek. The first spike occurred from September 8 to September 18, when 22% of the total was trapped and the second from October 7 to October 9, when 20% of the total was caught (Figure 10b).

Adult and Juvenile Scale Samples

We obtained scales from 24 adult steelhead trapped at the Kooskia National Fish Hatchery weir on Clear Creek and nine adult steelhead trapped in the Lemhi River. Mean fork lengths of the adult steelhead were 78 cm (sd = 5 cm) and 75 cm (sd = 7 cm) in Clear Creek and Lemhi River, respectively.

We obtained scales from 70 juvenile steelhead collected in Fish Creek, September 20 to 23, from the United States Fish and Wildlife Service (USFWS). The mean fork length of the fish was 121 mm (sd = 21 mm).

We have mounted and pressed the scales from these fish but have not estimated age as of this date.

DISCUSSION

We used the 1993 field season to begin selected experiments in Objectives 1 and 2, and to gather baseline data for Objective 5. We did not implement any of the tasks associated with the other objectives. Full implementation of the experimental design was not planned until 1995 (Byrne 1994).

The first objective of this study is to compare the performance of a wild stock with an established hatchery stock for supplementation. The experimental design called for us to stock two streams with hatchery adults and two with wild adults. We began this assessment, in the upper Salmon River drainage, by outplanting hatchery adults in 1993. Because of the low wild escapement, we were unable to obtain enough wild adults for outplanting. However, hatchery adults were stocked in Frenchman and Beaver creeks, spawning was documented, and fry were produced. We plan to monitor the survival and smolt production of this cohort by PIT tagged juveniles, yearly summer snorkel surveys, and trapping migrants. When the wild adult escapement increases, and we can obtain enough fish, we will outplant them into another upper Salmon River tributary and track their progeny in the same manner as the hatchery fish. We assessed four tributaries in the East Fork Salmon River for their feasibility in Objective 1 experiments. Because of the remoteness of the streams, and the logistical difficulties we would encounter when stocking adults, we judged all streams to be unfeasible for Objective 1 experiments.

The second objective of this study is to compare the production of progeny from returning adults released as fingerlings or smolts. We began this experiment in the South Fork Red River by stocking 50,000 marked fingerlings on September 1. The fish remained within the 3.5 km stream section where they were stocked. Two months after release, we determined that the fish had significantly increased in length, weight, and condition factor. The East Fork Salmon River drainage was the proposed location to replicate this experiment. Based on our feasibility analysis, this experiment could be implemented in the East Fork Salmon River drainage.

The primary purpose of our snorkeling this year was to obtain baseline data in study streams to help judge the success of adult outplants and to determine the status of steelhead populations in the East Fork Salmon River tributaries and Fish Creek. We found low densities of steelhead in all streams except Fish Creek (Tables 6-8). The Fish Creek juvenile steelhead densities, although the highest we observed, were only one-half to one-third the densities observed in 1987 (A. Byrne, IDFG, unpublished data).

The low abundance of juvenile steelhead in most streams caused a large number of zero steelhead counts and lead to a large variance in our mean density estimates and large confidence intervals around population estimates. The confidence interval approached or exceeded our estimated population total for Beaver and West Pass creeks (Table 9). Because of the high frequency of zero fish counts, increasing our snorkeling effort would not greatly reduce the confidence interval of the estimated population total. For example, we snorkeled 13 sites that contained 14% of the total stream surface area in Section 1 of Beaver Creek. The population total and CI of age 1 and age 2 + steelhead, in this section, was 87 ±94 and 52 ±97 fish, respectively. If we doubled the number of snorkel sites, and snorkeled 26% of the surface area, the CI would decline to ±62 age 1 and ± 64 age 2 + fish, given the same variance on mean steelhead densities.

We PIT-tagged 2,870 steelhead parr and smolts in 1993. By continuing our tagging in future years, we plan to obtain survival estimates from age 1 and age 2 parr to smolt from natural steelhead stocks. We plan to expand our summer stream PIT tagging into other wild streams, beginning in 1994. With only one year of data, it is premature to make many statements about migration characteristics of the different stocks we tagged. Given this limitation, 1993 migrants in the Clearwater River drainage (Crooked Fork Creek and Red River) were larger, migrated earlier in the spring, and later in the fall, than the migrants in the Salmon River drainage (Marsh Creek and South Fork Salmon River). Most of the steelhead we captured in the Salmon River drainage traps, during the spring, were parr. Because of the small number of detections at Lower Granite Dam ($n = 8$), the travel time statistics for Marsh Creek and South Fork Salmon River should be viewed with caution.

RECOMMENDATIONS

1. Choose two additional streams in the Salmon River, upstream of Sawtooth Fish Hatchery, for outplanting hatchery and wild adults. These streams will replace the East Fork Salmon River tributaries that were proposed study areas in the experimental design.

2. Because of the low number of wild steelhead, postpone collection and outplanting of wild fish for Objective 1 experiments for at least one year.

3. Expand effort in Objective 5: choose additional natural and wild steelhead streams, assess the status and trend by yearly snorkeling, collect parr for genetic and disease assessment, and use PIT tags and traps to gather life history characteristics of populations.

4. In 1994, begin a review of hatchery weir management in relation to natural production goals (Objective 3).

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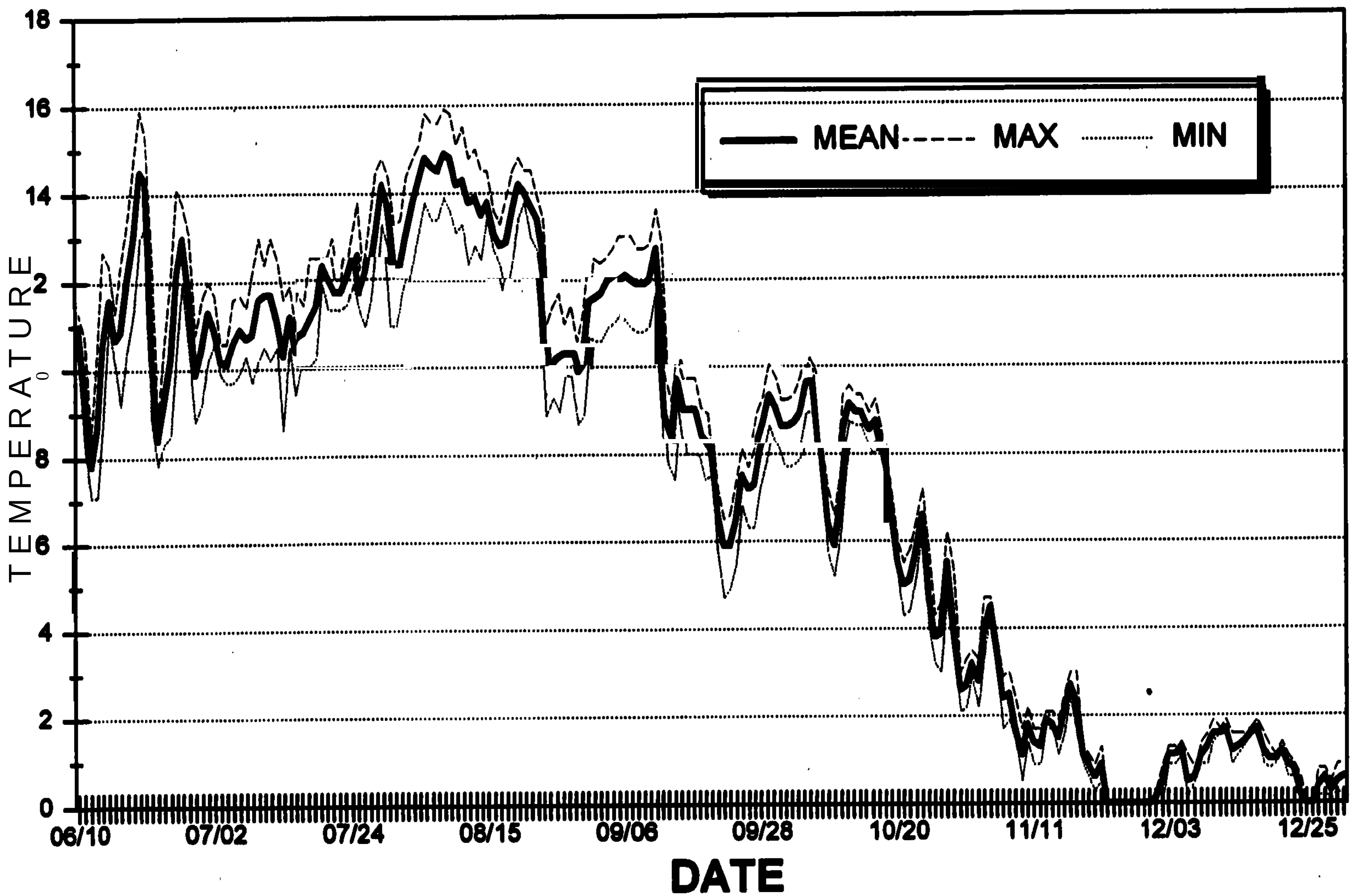
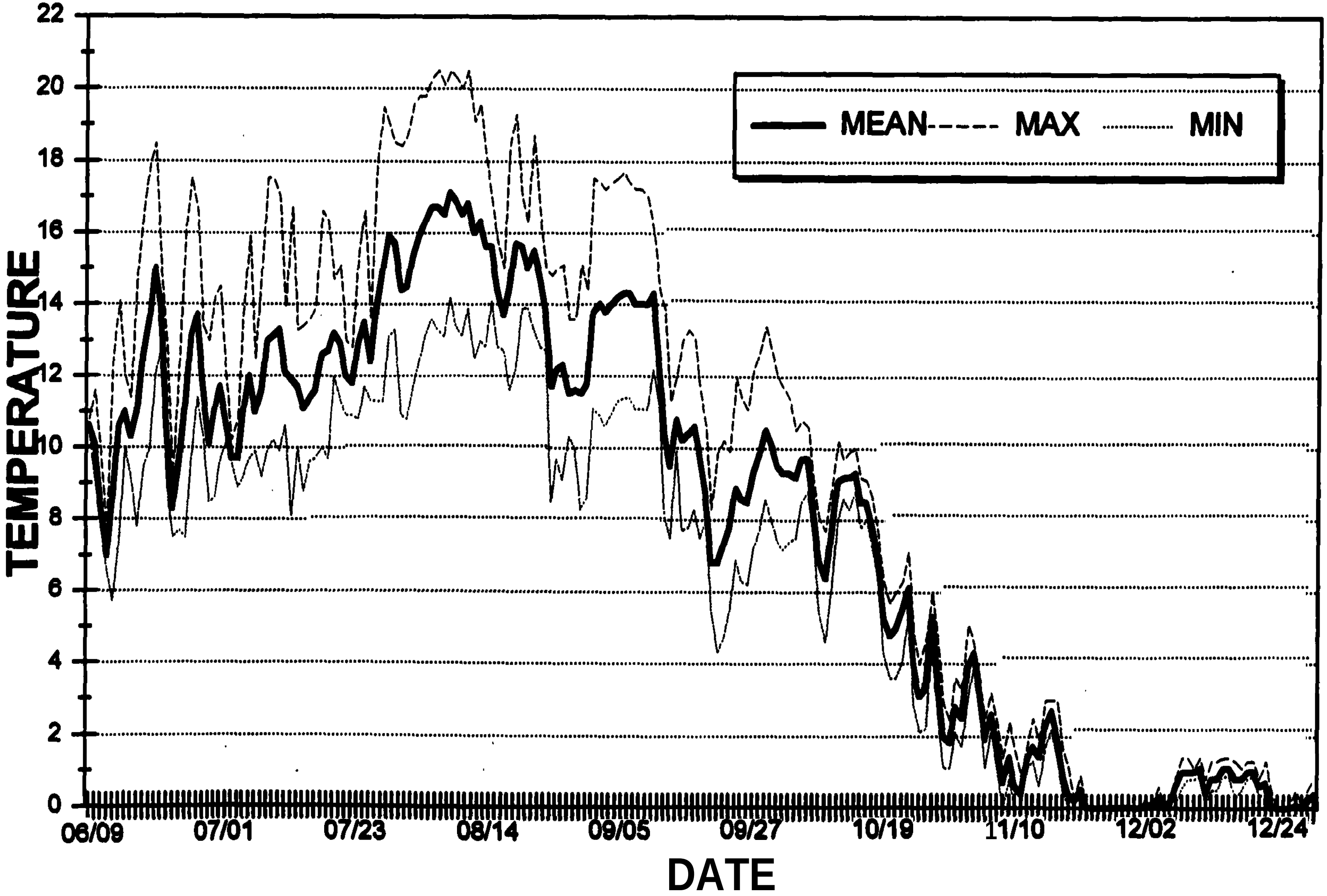
APPENDICES

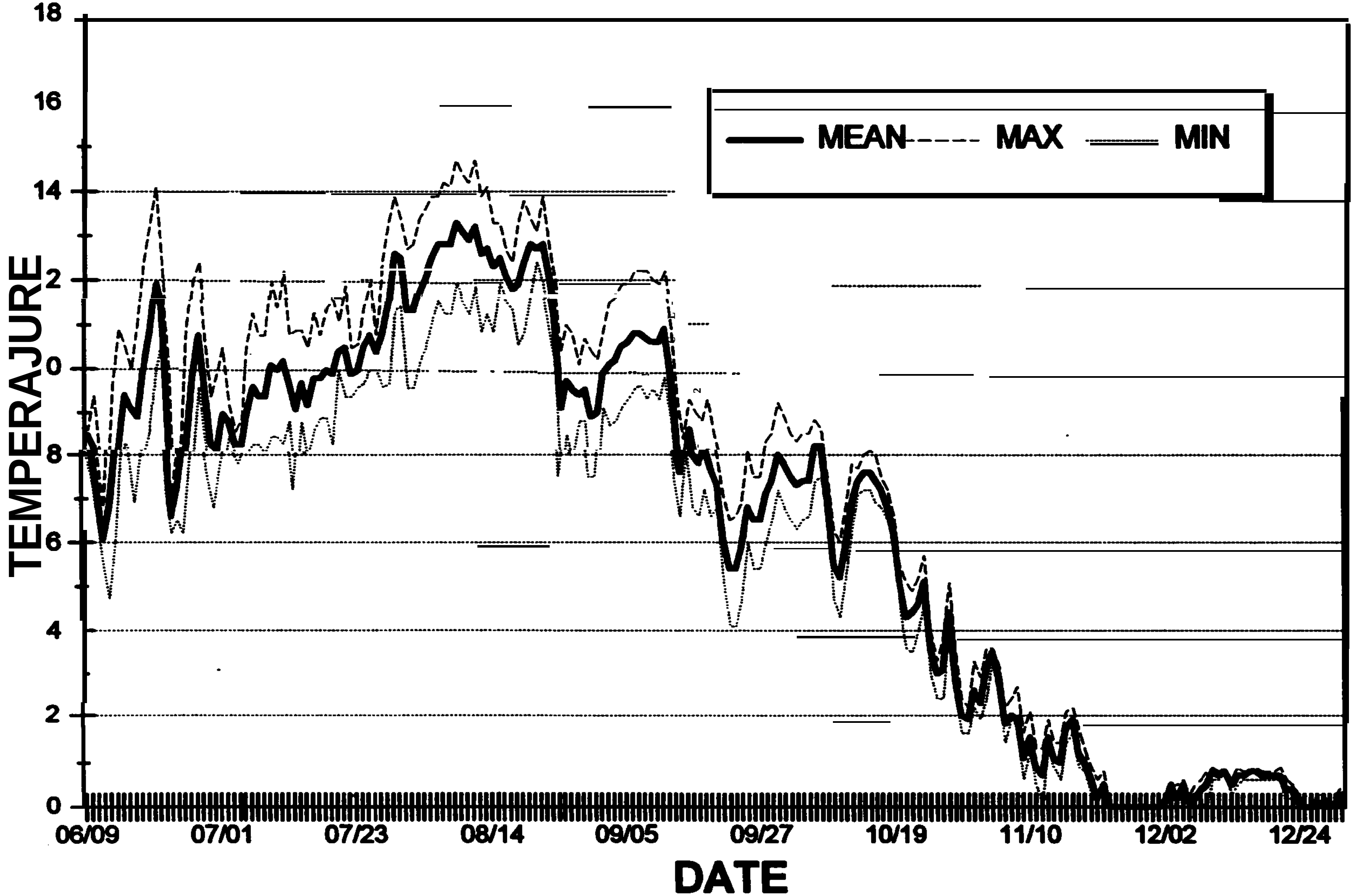
Appendix 1. The daily mean, maximum, and minimum stream temperature (C°) in Canyon Creek about 1 km upstream from its mouth.



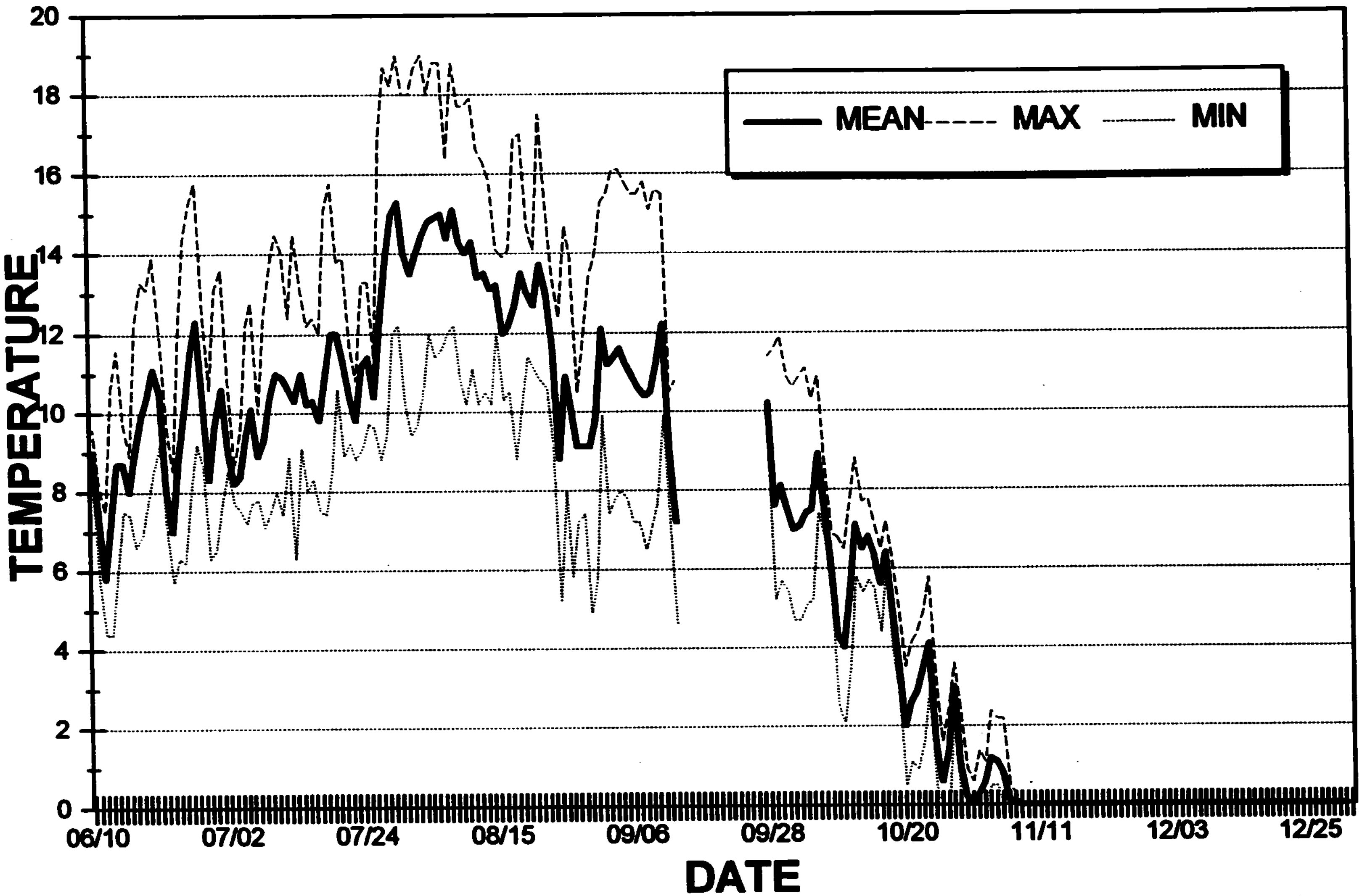
Appendix 2. The daily mean, maximum, and minimum stream temperature (C°) in Fish Creek about 1 km upstream of its mouth.



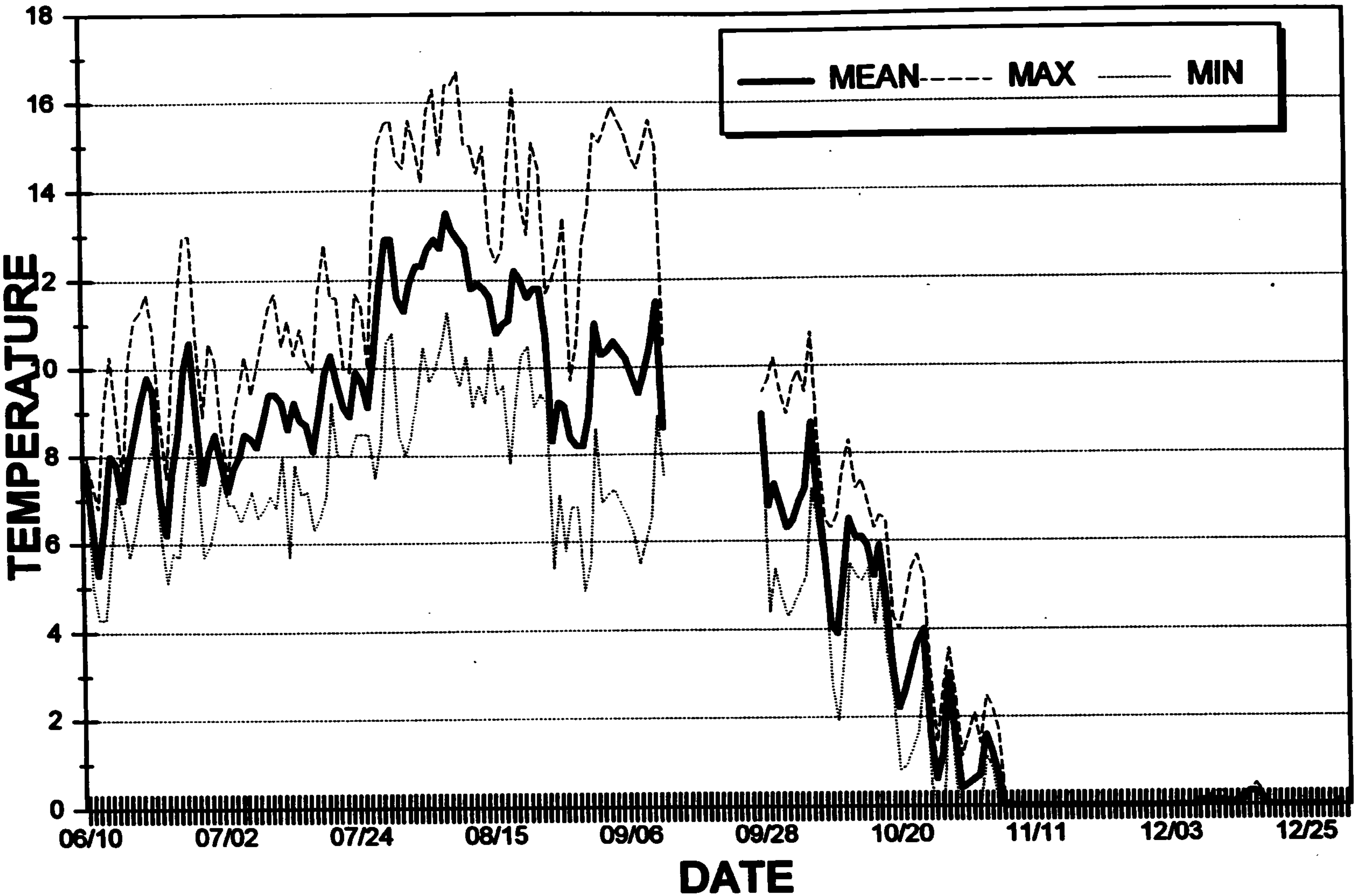
Appendix 3. The daily mean, maximum, and minimum stream temperature (C°) in Post Office Creek near its mouth.



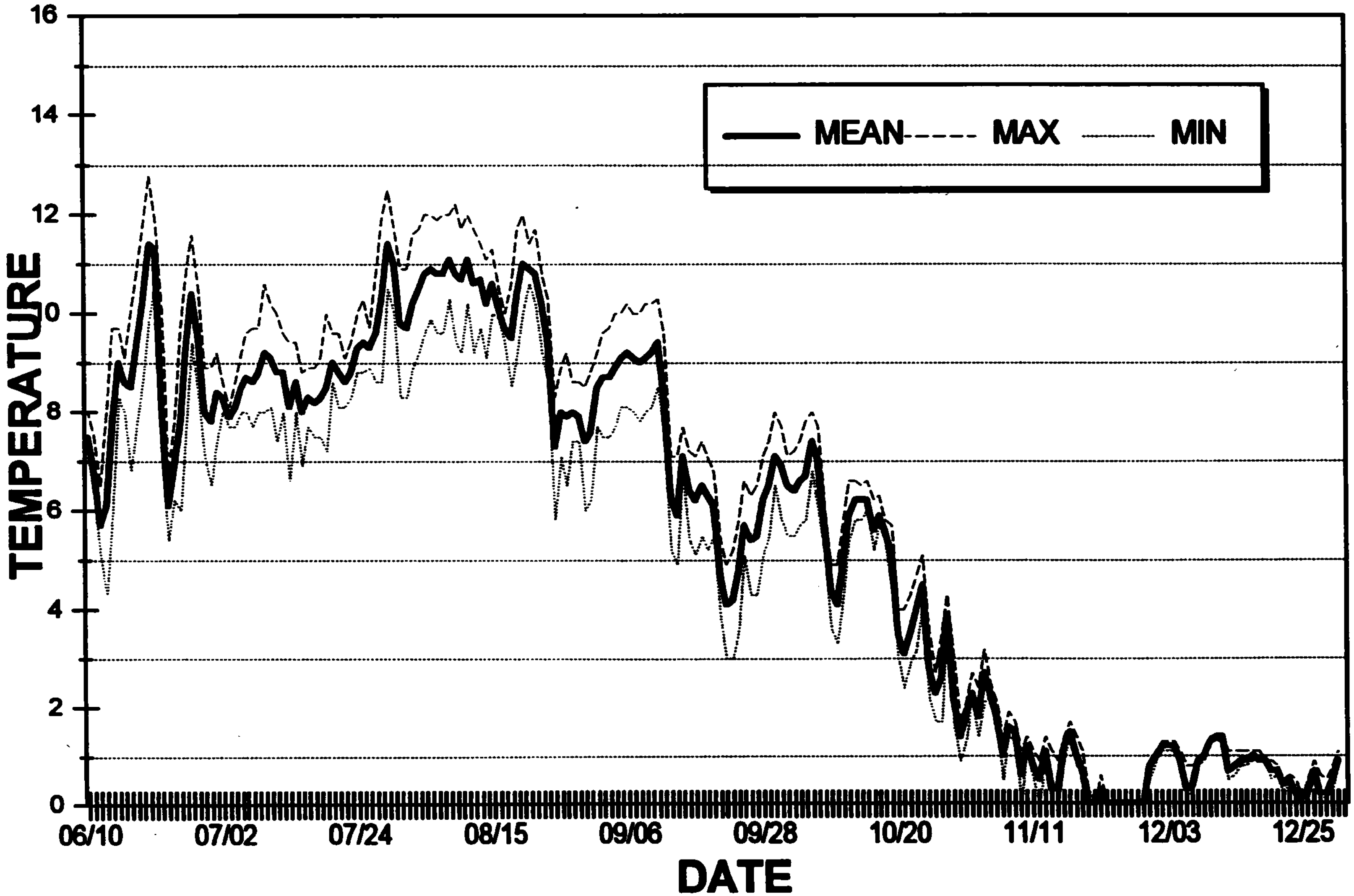
Appendix 4. The daily mean, maximum, and minimum stream temperature (C°) in Red River about 1 km upstream of the South Fork Red River. The temperature recorder was partially out of the water when it was downloaded on September 28.



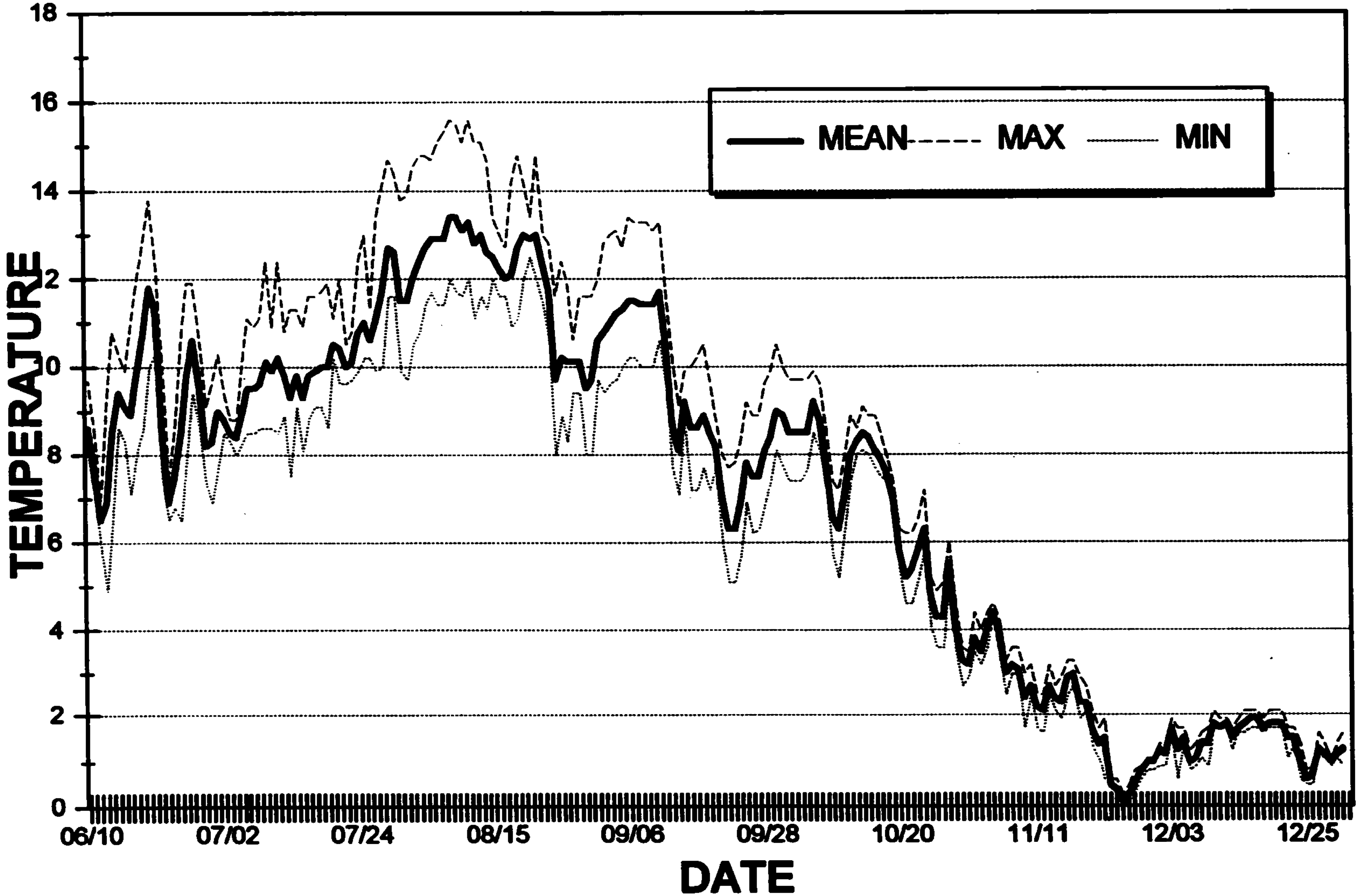
Appendix 5. The daily mean, maximum, and minimum stream temperature (C°) in the South Fork Red River just upstream of Schooner Creek. The temperature recorder was partially out of the water when it was downloaded on September 28.



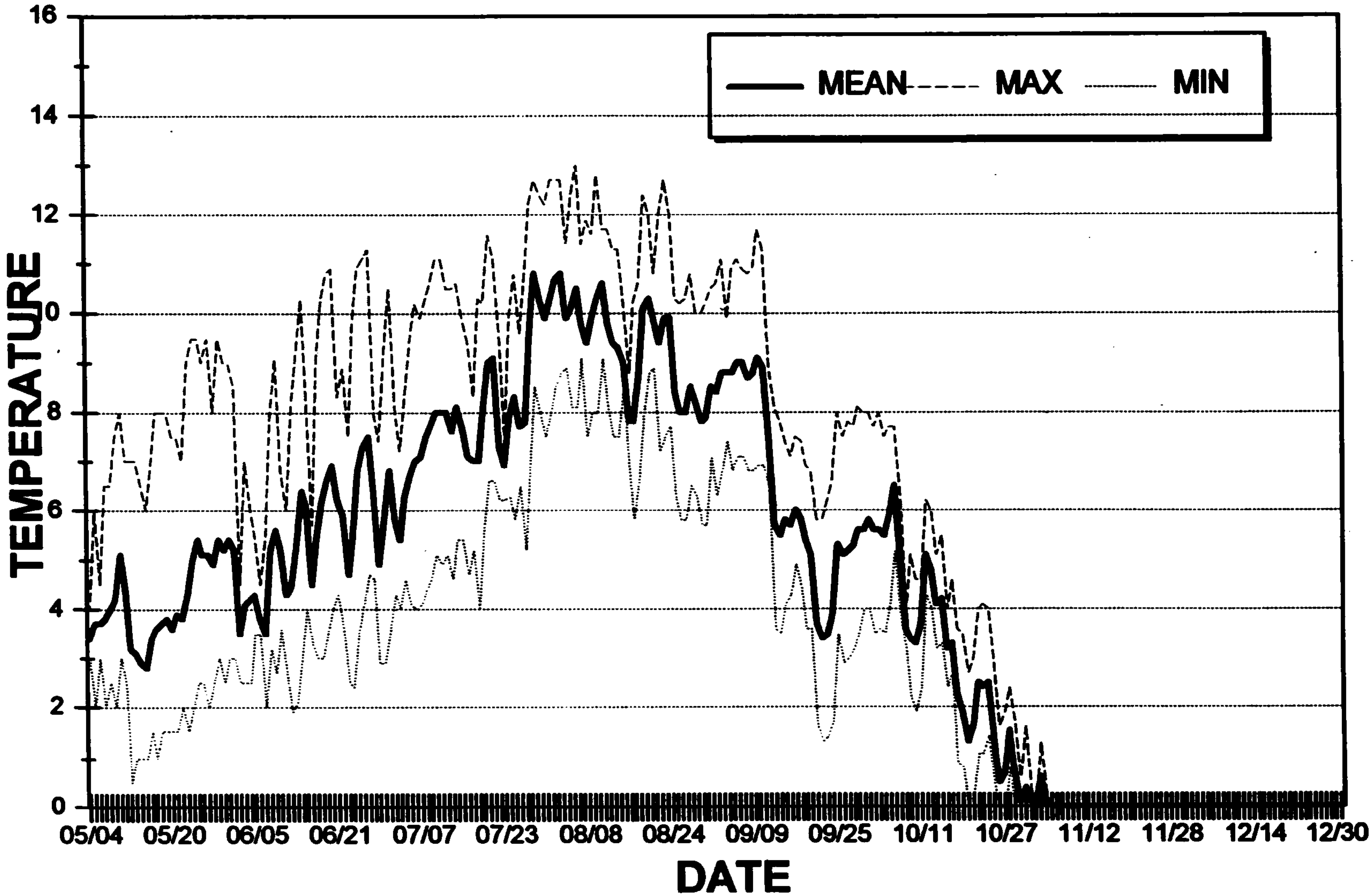
Appendix 6. The daily mean, maximum, and minimum stream temperature (C°) in Walton Creek about 1 km upstream of its mouth.



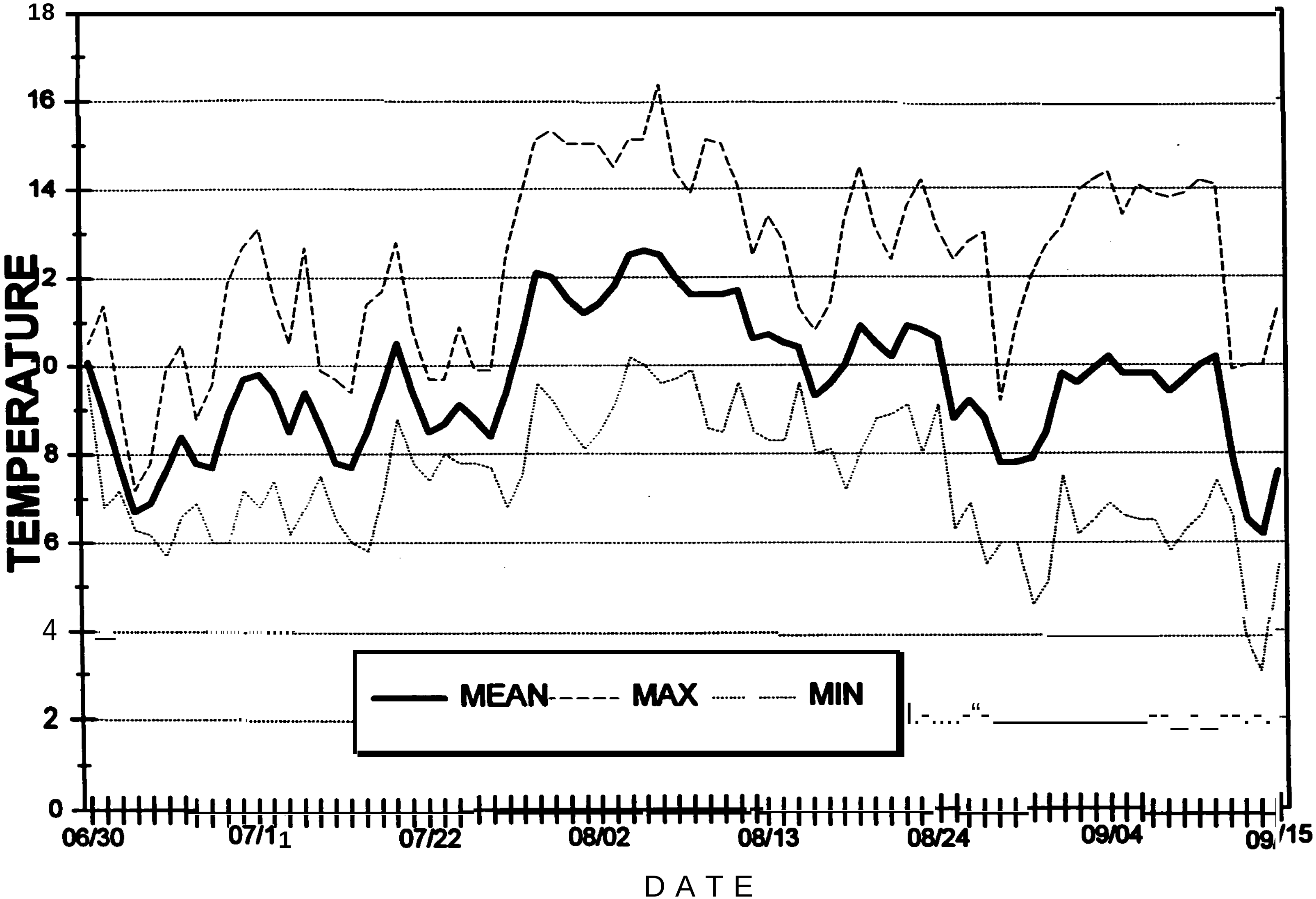
Appendix 7. The daily mean, maximum, and minimum stream temperature (C°) in Weir Creek near its mouth.



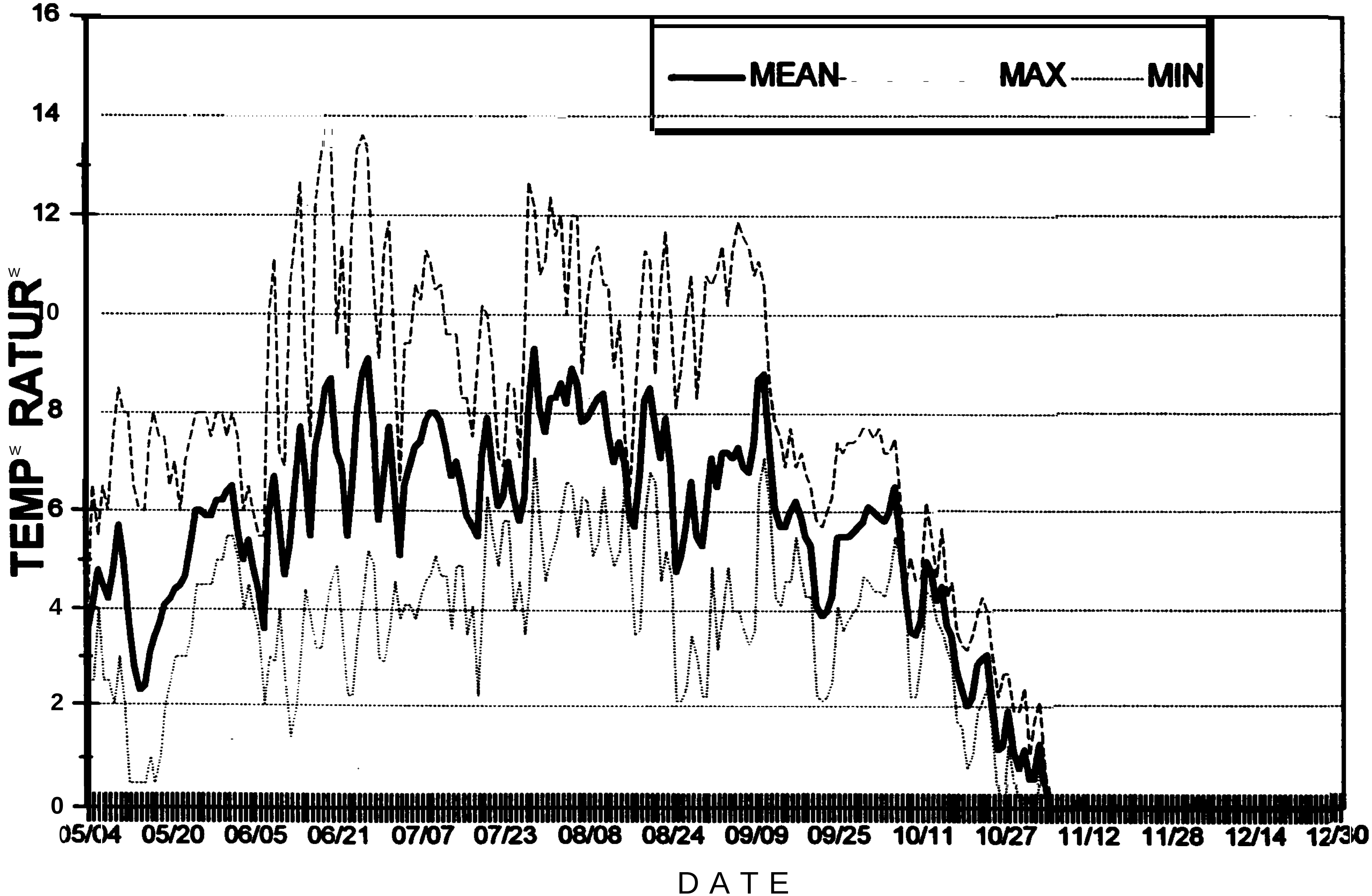
Appendix 8. The daily mean, maximum, and minimum stream temperature (C°) in Beaver Creek about 3 km upstream of its mouth.



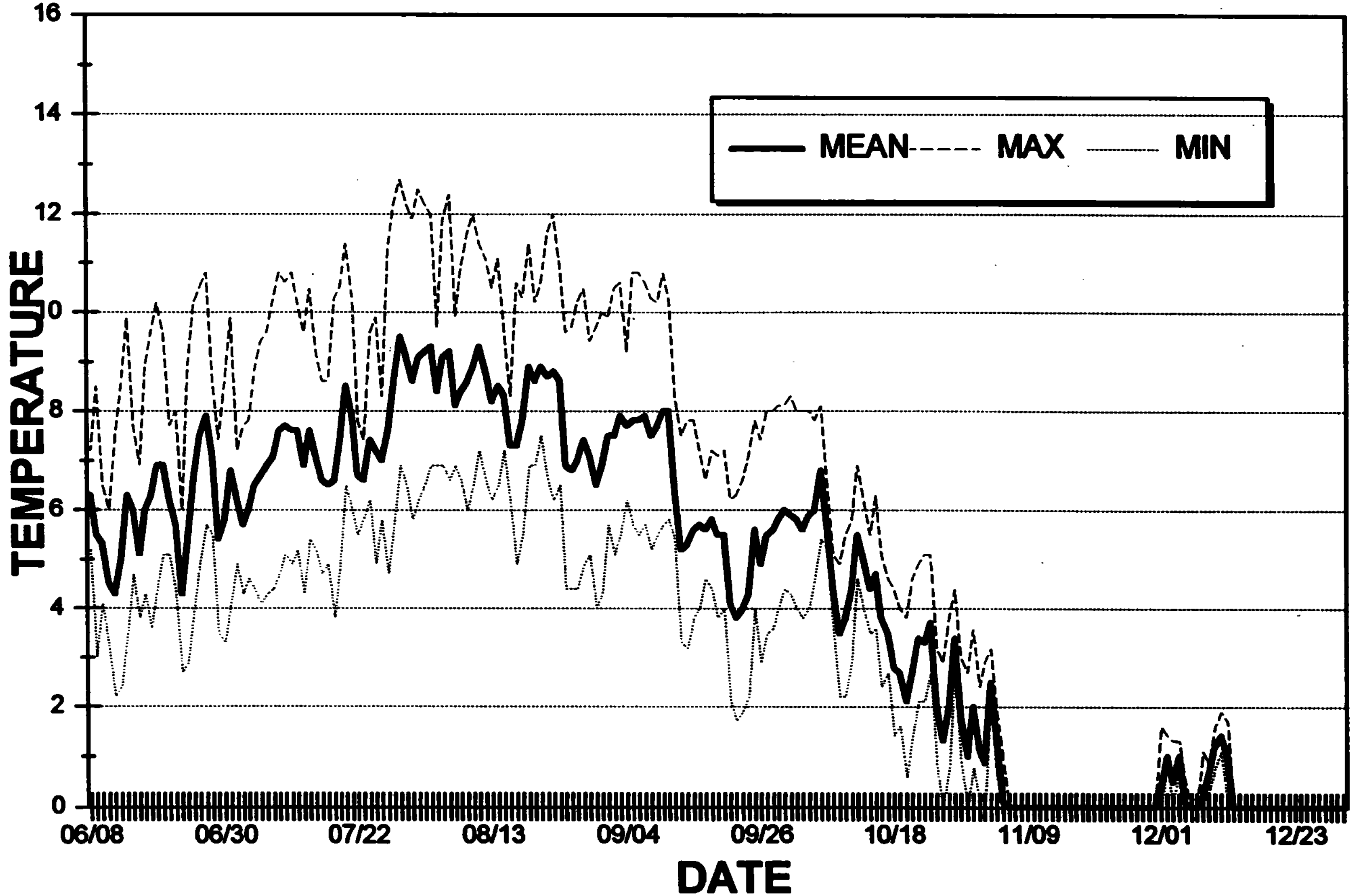
Appendix 9. The daily mean, maximum, and minimum stream temperature (C°) in Chamberlain Creek near Hotzel Ranch.



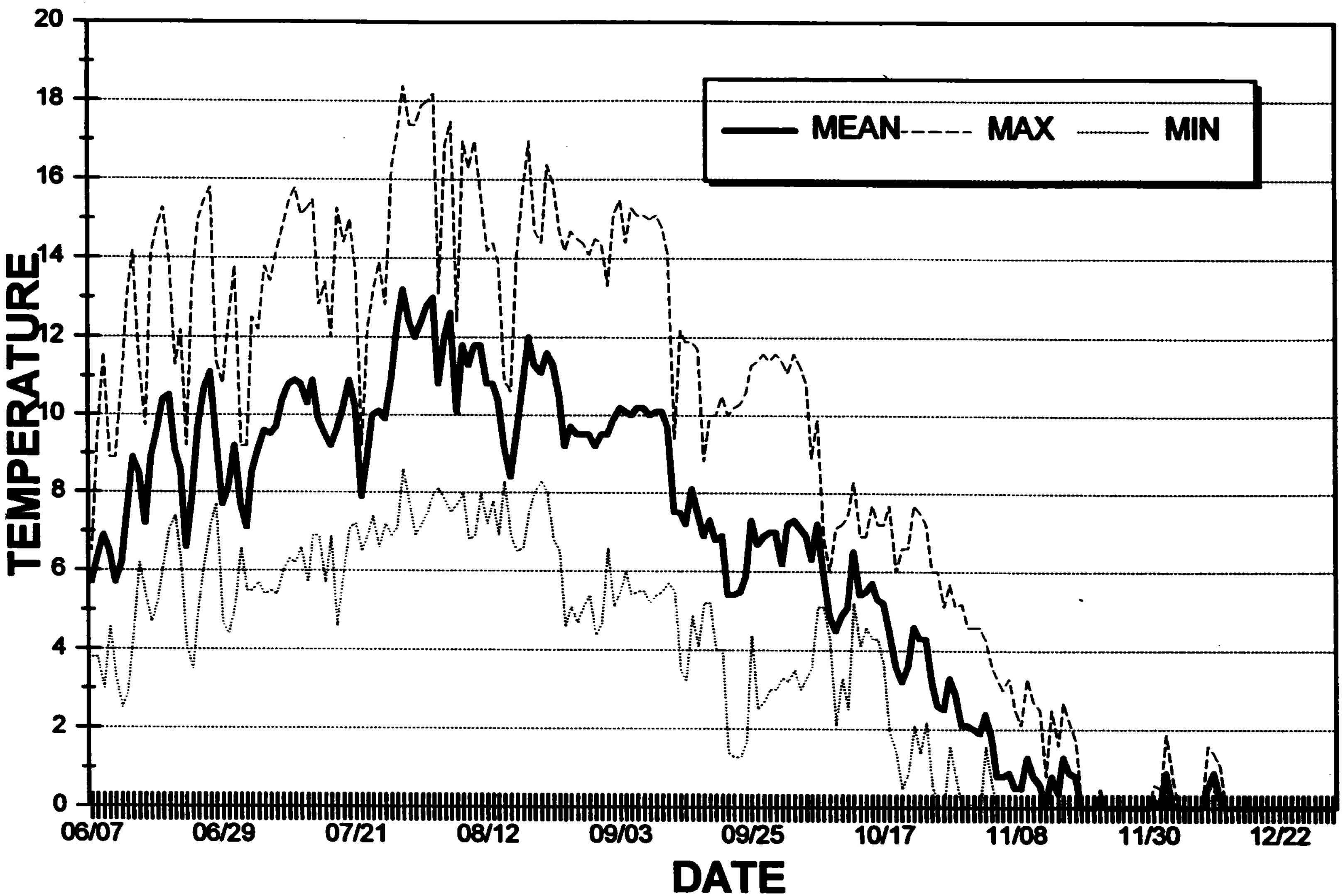
Appendix 10. The daily mean, maximum, and minimum stream temperature (C°) in Frenchman Creek about 3 km upstream of its mouth. The recorder was repositioned in the stream after it was found out of the water on September 9.



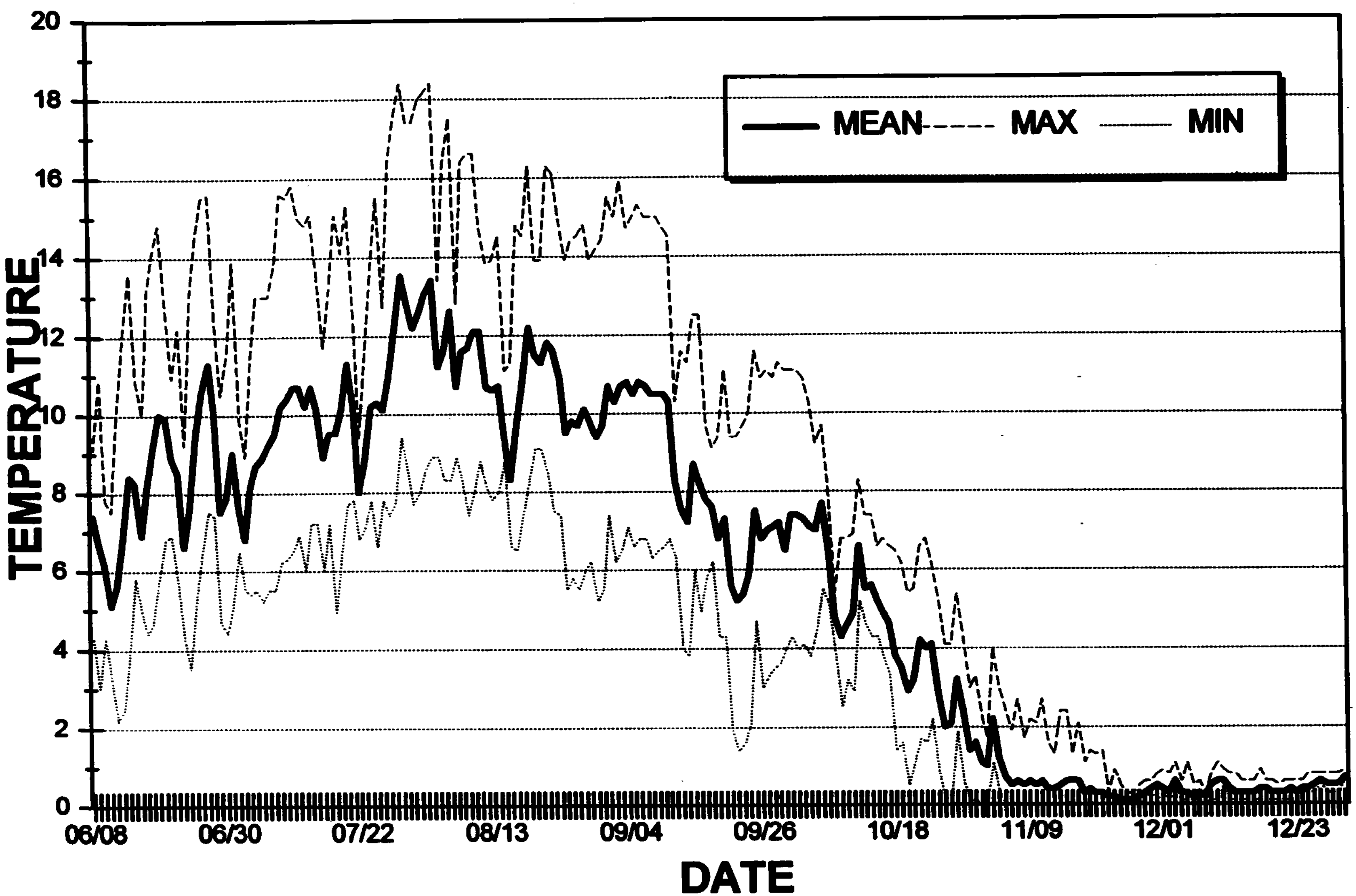
Appendix 11. The daily mean, maximum, and minimum stream temperature (C°) in Germania Creek near its mouth.



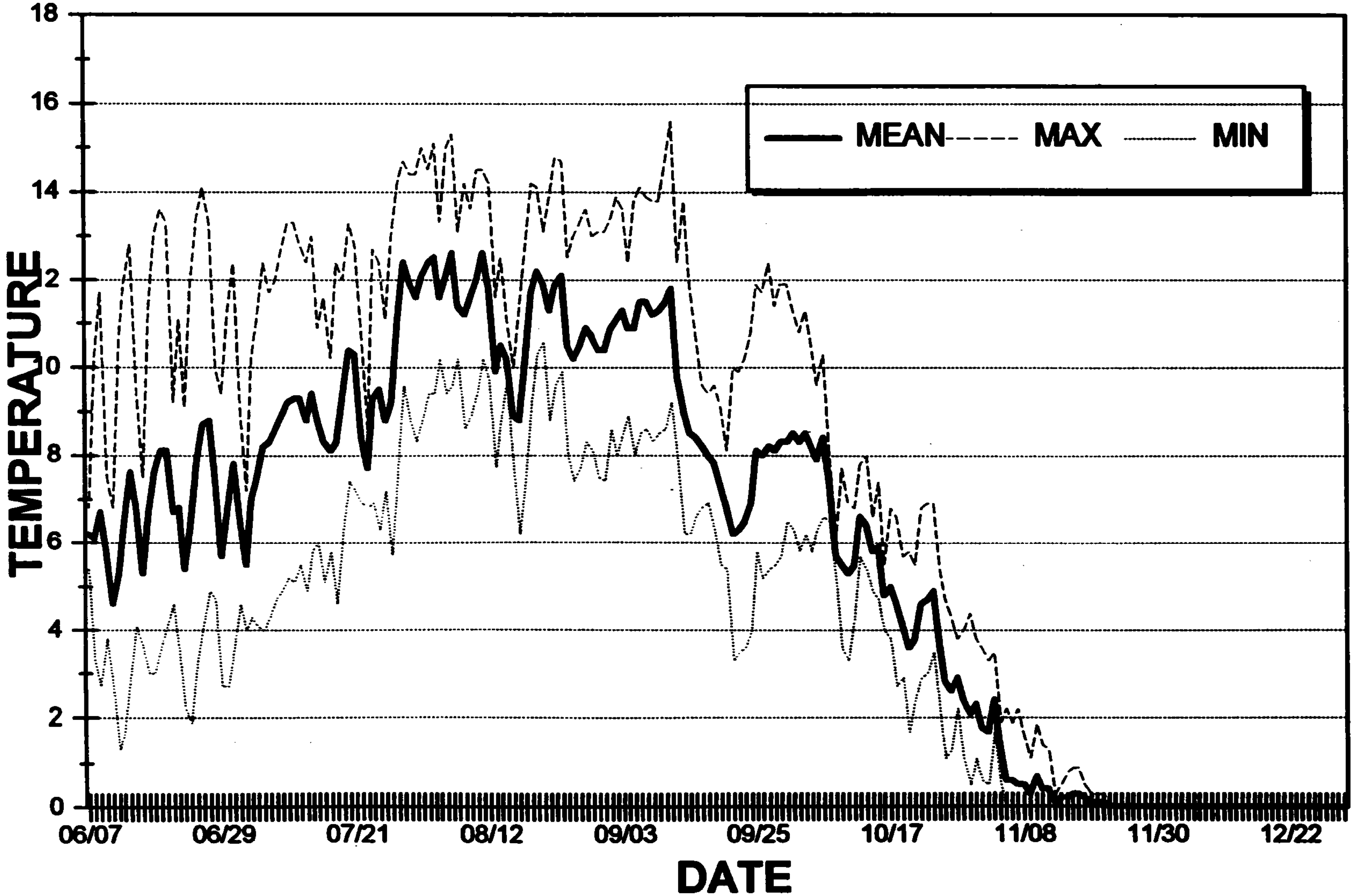
Appendix 12. The daily mean, maximum, and minimum stream temperature (C°) in Marsh Creek just upstream of Capehorn Creek.



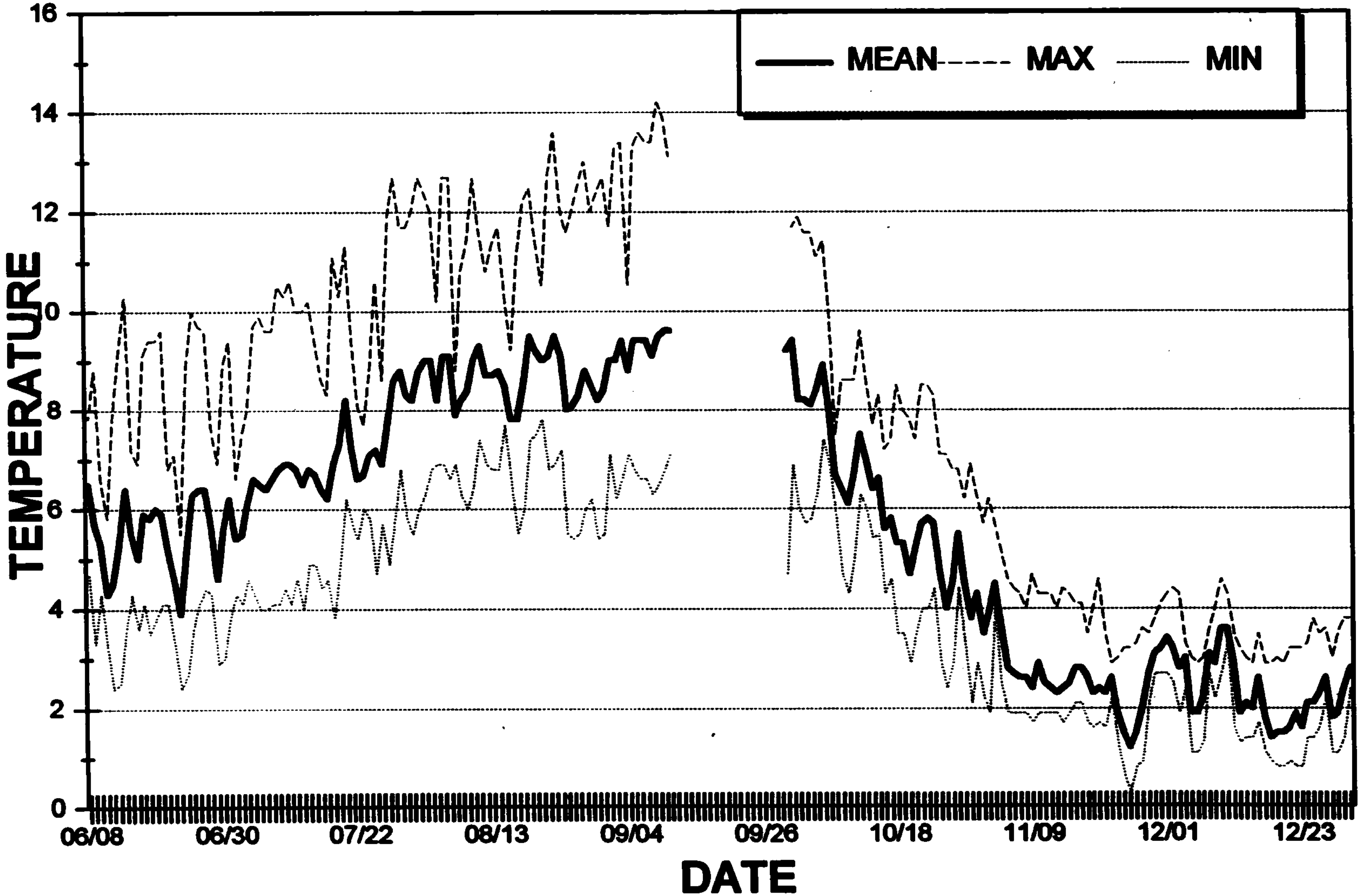
Appendix 13. The daily mean, maximum, and minimum stream temperature (C°) in Valley Creek just upstream of Meadow Creek.



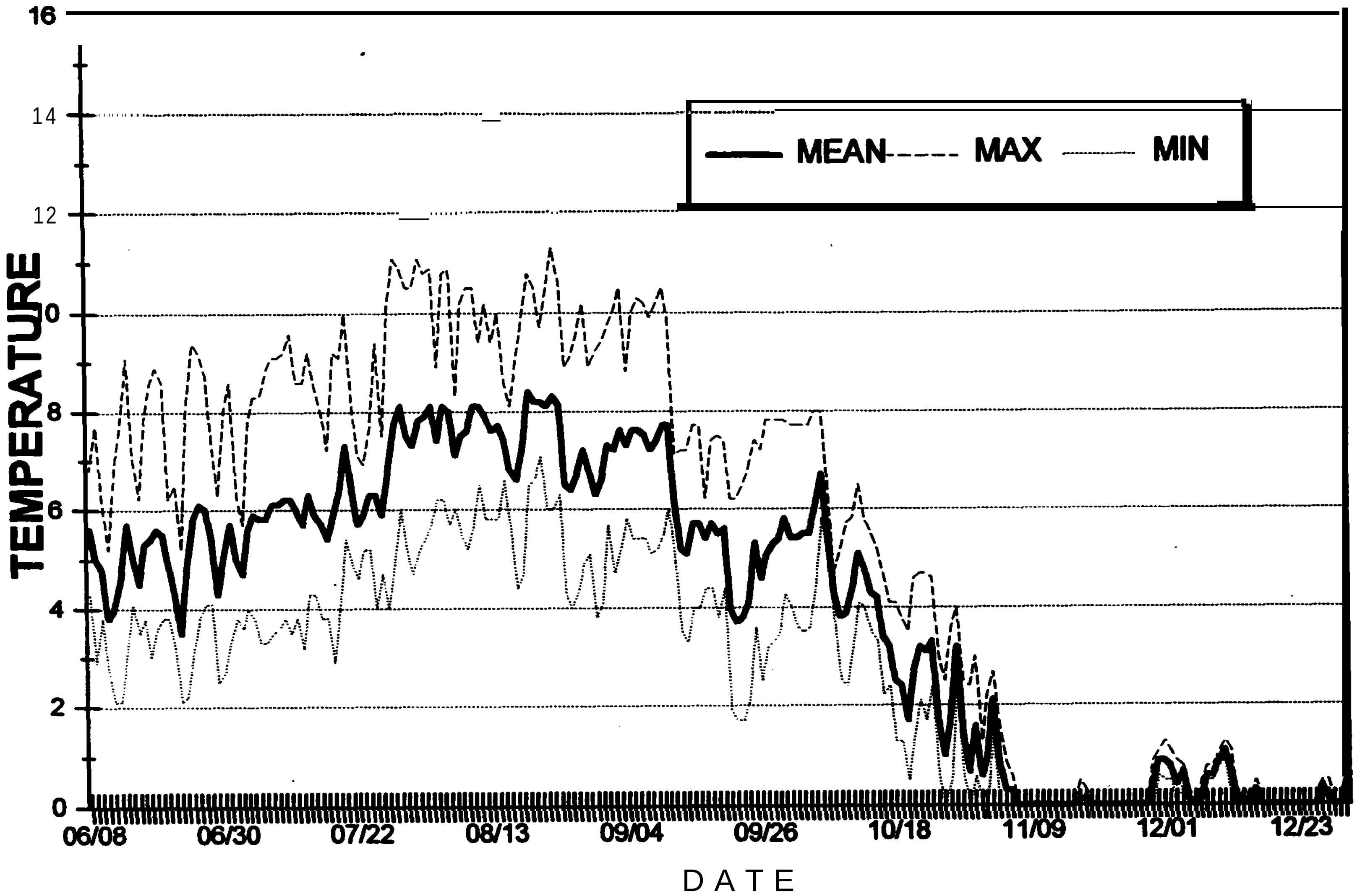
Appendix 14. The daily mean, maximum, and minimum stream temperature (C°) in Smiley Creek about 5 km upstream of its mouth.



Appendix 15. The daily mean, maximum, and minimum stream temperature (C°) in the East Fork Salmon River about 0.5 km upstream of the Bowery Guard Station. The temperature recorder was partially out of the water when it was downloaded on October 1.



Appendix 16. The daily mean, maximum, and minimum stream temperature **(C°)** in West Pass **Creek** just **upstream** of the irrigation **diversion.**



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